

# SCIENCE

AUGUST 22, 1952

VOLUME 116

NUMBER 3008

## Contents

- Systematic Analysis of Factors Determining Accuracy in Visual Tracking: *Robert S. Lincoln and Karl U. Smith* 183

### News and Notes

- International Union of Biological Sciences: *P. Vayssiére and Stuart Mudd* 188

### Technical Papers

- Rapid Serial Recording of Concentrations in the Blood Circulation and in Perfusion Systems: The Effluogram: *James M. O'Brien and Walter S. Wilde* 193

- Effect of Peripheral Shielding on Lymphoid Tissue Response to Irradiation in C 57 Black Mice: *Henry S. Kaplan and Mary B. Brown* 195

- An Investigation of Antimony Oxide as an Opacifier for Porcelain Enamels and Glass: *A. E. Pavlish and L. S. O'Bannon* 196

- Some Patterns of the Respiratory Pigments of Ascites Tumors of Mice: *Britton Chance and LaRoy N. Castor* 200

- The State of Catalase in the Respiring Bacterial Cell: *Britton Chance* 202

- Schwarzschild-Villiger Effect in Mierspectrophotometry: *Leonard Ornstein and Arthur W. Pollister* 203

- Study of Irritants Related to Piperine: *Torsten Hasselstrom, Harold W. Coles, and Norene E. Kennedy* 204

### Comments and Communications

- Libero Ajello, I. R. C. Bick, P. S. Clezy, Lucille K. Georg, Morris A. Gordon, Otto Struve, M. Wharton Young, and L. D. Zeidberg* 206

### Book Reviews

- Principles of Geochemistry; Smithsonian Logarithmic Tables to Base e and Base 10; Electrical Measurements; A Colored Atlas of Some Vertebrates from Ceylon* 209

- Scientific Book Register** 210

- Shadow-Casting Meteors** 3

- Meetings & Conferences** 12

AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

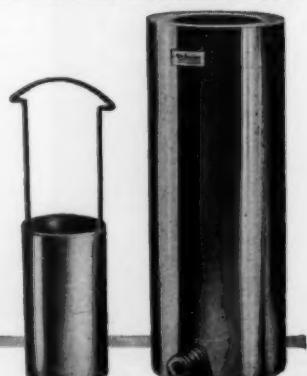
**they'll be clean as a whistle . . . in 3 minutes!**



It's the patented Technicon syphon-cycle that does it. Twice every minute, seven fresh gallons of water are surged through the pipettes, loosening and dislodging clinging residues. Wastes are literally swept out by the violent suction set up during the brisk ten-second emptying phase of the cycle.

So rapid, so thorough is the Technicon Washer that six flushing cycles will deliver a full basket-load of immaculately clean pipettes (it holds up to 200 pipettes, 1 ml, 18" long). The non-corroding stainless steel basket carries its load of pipettes without changing through cleansing, washing and drying. Practically eliminates breakage and chippage because it requires no individual handling, no shifting from container to container. A **MUST** for the busy laboratory. Ask for Bulletin 6150 giving particulars.

You're looking at a load of soiled pipettes going into the Technicon Pipette Washer. Three minutes from now they'll be out again — but sparkling clean!



**technicon**  
automatic pipette washer

THE TECHNICON COMPANY, 215 EAST 149th ST., NEW YORK 51, N. Y.

**new (6th) edition!**

**MAXIMOW  
and BLOOM'S  
TEXTBOOK  
of HISTOLOGY**

**986 illustrations**

**257 in color**

**on 580 figures**

Now, more than ever before, MAXIMOW AND BLOOM is the foremost textbook in its field. Always widely used in both college and medical school courses, it is now proving even more valuable because of the many improvements made in the revision for this *New (6th) Edition*.

Dr. William L. Doyle has blended new information on the *submicroscopic structure of protoplasm* with the general description of the cell and its minute structure. For the first time, cytochemistry and cellular metabolism are discussed understandably from the structural viewpoint.

The chapters on the blood have been completely rewritten by Dr. P. P. H. DeBruyn. Clearly and concisely he shows just what potentialities the various lymphocytes have. The information on macrophages has been gathered together and discussed as a unit.

The section on the microscopic, functional anatomy of the endocrines has been rewritten by Dr. I. Gersh—with a chapter for each gland.

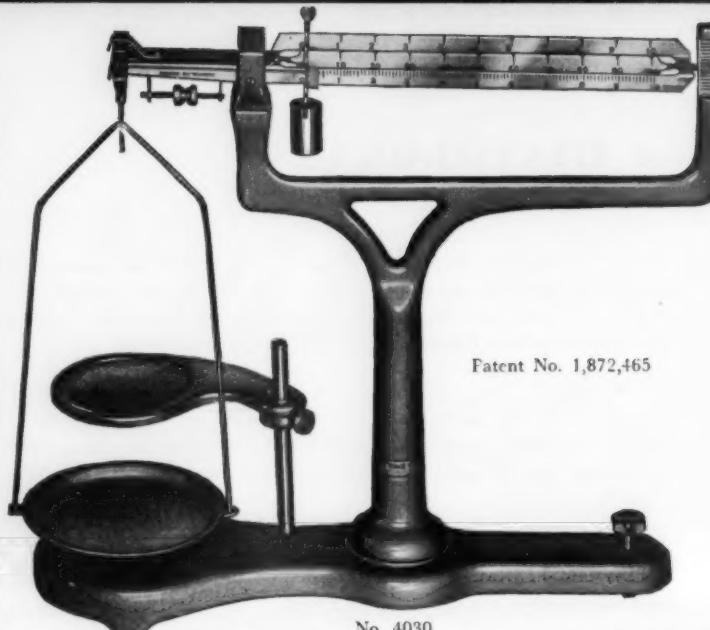
No one will deny that MAXIMOW AND BLOOM contains the *best illustrations of human material* ever brought together in one book. In this *New (6th) Edition*, there are 75 new illustrations, with 22 in color. Included are new color photomicrographs, photomicrographs by phase contrast of living cells, and low power photomicrographs showing the striking facts due to the action or withdrawal of hormones.

By ALEXANDER A. MAXIMOW; and WILLIAM BLOOM, Professor of Anatomy, University of Chicago. 616 pages, 6½" x 10", with 986 illustrations, 257 in color, on 580 figures. \$10.00.  
*New (6th) Edition.*

**W. B. SAUNDERS COMPANY**  
**West Washington Square**      **Philadelphia 5**

# The Ideal Balance for Rapid, Accurate, Weighing

Includes All the time-tested SUPERIOR FEATURES



Patent No. 1,872,465

No. 4030

## CAPACITY

111 g. (With extra weight 201 g.)  
CORROSION-RESISTANT!

All exposed metal parts are stainless steel. A tough, tenacious, chip-proof, metallic lacquer is used on the base and beam support.

## FUNCTIONALLY DESIGNED!

Scales are stepped upward front to rear for best eye-level visibility and to make weights convenient to manipulate. The larger weights have sharp hanger edges and their beams are deep-notched to insure that settings will be positive and accurate.

**No. 4030 Triple-Beam Balance—Stainless Steel  
EACH \$22.25 Extra Weight \$1.30 Additional**

WRITE FOR OUR 120-page CHEMICAL APPARATUS CATALOG INCLUDING NO. 4030  
AND MANY OTHER WELCH ITEMS FOR THE CHEMISTRY LABORATORY

## SENSITIVITY

0.01 g. or less

## ONE-PIECE BEAM CONSTRUCTION!

No screws, rivets, or separate scales to become loose.  
Hard-to-clean crevices and cracks are eliminated.

## RAPID ZERO SETTING!

The usually tedious adjustment to zero is accomplished almost instantly by means of a leveling screw. No more careless acceptance of a poor zero setting because of the nuisance of correcting it!

**W. M. WELCH SCIENTIFIC COMPANY**

Established 1880

1515 SEDGWICK STREET, DEPT. E

Manufacturers of Scientific Instruments and Laboratory Apparatus

CHICAGO 10, ILLINOIS, U.S.A.



Gladys M. Keener  
Executive Editor

**AAAS EDITORIAL BOARD**

(Terms expire June 30, 1958)

Howard A. Meyerhoff, Chairman

William R. Amberson Bentley Glass

Wallace R. Brode Karl Lark-Horovitz

Walter J. Nickerson

F. A. Moulton, Advertising Representative

## Shadow-Casting Meteors

THE fall of a brilliant meteor is one of the most awe-inspiring of natural phenomena. Aviators have banked their planes, cars have been driven nearly into the ditch, and pedestrians have run to dodge a meteor more than fifty miles away. Closer to the real end point, the light and detonations have stampeded farm animals.

From the considerable number of meteors reported in Iowa alone during the latter half of 1951, we have selected as shadow-casting and as probably dropping meteorites the following: (a) July 28, ending near Centerville—detonations fifty miles back along the path; (b) August 30, ending near Creston—detonations; (c) November 7, ending near Norman, Oklahoma—daylight, detonations eighty miles back along the path; (d) November 9, ending near Red Oak, Iowa—drivers of cars were startled by sudden lighting of the surrounding landscape (reported from Indiana to Nebraska).

Let us examine some typical first reports on a shadow-casting meteor. A woman reported that she had seen a ball of fire fall through a tree in her neighbor's yard in Omaha, Nebraska; at the same time men reported that they had seen a flaming airplane fall into Lake Michigan at Milwaukee. A meteor worker analyzing these reports would assume that the meteor, which must have ended at a height of several miles, was at least 50, but probably not more than 400, miles from Omaha, and a comparable distance from Milwaukee. Hence the meteor might have fallen in Wisconsin, Minnesota, Illinois, Iowa, or Missouri.

Let us assume, however, that an Omaha resident with scientific training had heard the lady's report over a radio station and had promptly called her by telephone. He could have found out in two or three minutes that the meteor fell roughly due east of

Omaha, that it deviated from south toward north as it fell, and that the path made an angle of less than 45° with the horizon. A trained resident of Milwaukee could have discovered just as quickly that the meteor fell south-southwest of Milwaukee, that it deviated from south toward west as it fell, and that the path made an angle of more than 45° with the horizon. From these simple facts anyone with a map of the region could have located the meteor fairly closely by drawing lines eastward from Omaha and south-southwestward from Milwaukee. The intersection of these lines would have been close to the real end point of the meteor.

Approximately a hundred meteors large enough to drop meteorites fall in the United States each year, but only one or two recoveries of freshly fallen meteorites are recorded annually. To increase the number of recoveries we suggest that scientists emphasize in teaching and in conversation that a person's guess on the actual height and distance of an unfamiliar object is worthless. Let each scientist use his influence to make the press stories from his area include the direction of the fall. For each 250,000 square miles there should be two or three persons sufficiently alert and so situated as to obtain the direction of a brilliant meteor from two or more well-separated points and thus to give the real location. Finally, let geologists become reasonably familiar with the characteristics of meteorite falls. From the stories of recovery of supposed meteorites following the fall of a brilliant meteor, one could soon differentiate with some confidence between the genuine meteorites and most "meteorongs," even before the stones are seen. The probability of greater recoveries makes such a project of public education worth the effort.

C. C. WYLIE

Department of Astronomy  
University of Iowa

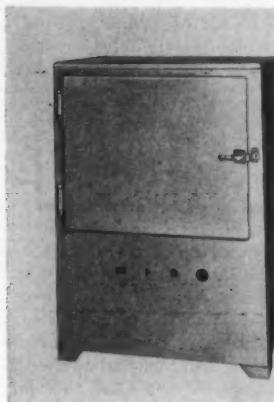
is required for change of address, and an address stencil label from a recent issue must be furnished. Claims for a missing number will be allowed only if received within 60 days from date of issue.

Annual subscriptions, \$7.50; single copies, \$1.25; foreign postage, outside the Pan-American Union, \$1.00; Canadian postage, \$1.50. Special rates to members of the AAAS.

The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates on request.

Cable address: ADVANCESCI.

Paper Partition  
CHROMATOGRAPHY EQUIPMENT



WRITE FOR CATALOG

**RESEARCH EQUIPMENT CORPORATION**

Manufacturers

Dept. S, 1135 Third Street  
Oakland 20, California

A new and more complete line of paper chromatographic equipment, carefully engineered for use in this new field of analysis.

CHROMATOGRAPHY DRYING OVEN

Also Available:  
New Chromatocab Models  
Strip Suspension Racks (stainless steel or glass)  
Electronic densitometers  
Ultraviolet Lamps (long and short wave-length)  
Indicator Sprays  
Disc Chambers  
Solvent Troughs & Assemblies  
Micro Pipets  
Clips

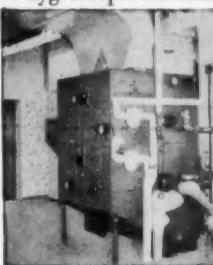
## Drying Problem Solved by New Method

New, Niagara "Controlled Humidity" Method provides air at precise conditions of temperature and humidity and permits accurate variations of such conditions at will, in the range of 34°F. to 140°F., also below 32°, if required.

This Method uses "Hygrol" liquid absorbent to remove moisture from the air directly, saving the cost of refrigeration for dehumidification. Operation is completely and reliably automatic; the absorbent is re-concentrated as fast as it is used.

It is used successfully in drying processes, control of hygroscopic materials, preventing moisture damage to materials or instruments, providing controlled atmosphere for tests and experiments. Units provide capacity ranges from 1000 c. f. m. to 20,000 c. f. m.

Write for Bulletin No. 112; address Niagara Blower Co., Dept. SW, 405 Lexington Avenue, New York 17, N.Y.



DID YOU EVER WISH FOR A HAND?

A FOOT SWITCH MADE OF NEW SURPLUS MATERIAL  
\$4.95 KIT \$5.75 COMPLETE  
USING A 15 AMP. MICRO SWITCH

REDMOND 115 V. A.C. 5" DIA. 2" ORIFICE, POWERFUL BLOWER OR EXHAUST FAN FOR LABORATORY ETC. \$7.85

ALNICO LUCKY PURCHASE 7% COBALT  
ENABLES US TO OFFER YOU THESE ACTUAL SIZE MAGNETS!  
39¢ EACH 3 FOR \$1.00

DO YOU SUFFER FROM HIGH VOLTAGE?  
DO YOU STRUGGLE WITH LOW VOLTAGE?

A Westinghouse 100 Watt Isolation Transformer will be your solution 150 V. to 110 V. or 110 V. to 150 V. or any voltage 40 V. up or down. Wght. 6 lbs. \$6.50

18 W. 115 Volt AC Synchronous Motor .. \$4.75

ALL PRICES F.O.B. N. Y.  
EST. 1923 BLAN EST. 1923  
64 Dey St. New York 7, N. Y.

*Have You Investigated*  
**GLUCURONOLACTONE?**

now available in commercial quantities

Glucuronic Acid is an important structural constituent of essentially all fibrous and connective tissues in animals, and is present in low concentrations in normal blood and urine. It is therefore of vital interest to investigators of body processes, diseases and treatments.

Appearance.....	White, crystalline powder
Odor.....	None
Melting point, °C.....	172
Specific rotation, (a) D.....	+20° (in H <sub>2</sub> O)
Specific gravity, 30/4°C.....	1.76
pH, initial.....	3.5 (10% aq. soln.)
Particle size.....	99% finer than 100 mesh

We can supply commercial quantities of Glucuronic acid produced synthetically from D-glucose, in 5 lb. and 50 lb. containers.

Send for this Booklet

which reviews recent literature pertaining to the uses for Glucuronic acid



Chemical Division

**CORN PRODUCTS REFINING CO.**

17 BATTERY PLACE • NEW YORK 4

# NEW

## A COMPLETE LIST OF C<sup>14</sup> CHEMICALS

NOW NUCLEAR offers you the advantages of a complete line of radiocarbon compounds. Through agreement with the British Ministry of Supply, Nuclear has been appointed exclusive U. S. distributor for all radiocompounds produced by the Radiochemical Centre, Amersham, England. All those in the attached list are quickly available, and other chemicals can be supplied on request. Compounds previously offered by Nuclear are of course still available. Future announcements will be made as this line of standard compounds is expanded.

Most compounds listed are now available for immediate shipment from Nuclear stock, under regular A. E. C. licensing procedures. Write for the complete chemical price list.

**NEW nuclear CONDENSED CATALOG**  
Up-to-the-minute data on the complete line of NUCLEAR Instruments and Accessories is shown in the new Condensed Catalog. Your copy will be sent by return mail—free. Write for it now.



nuclear INSTRUMENT & CHEMICAL CORPORATION  
237 West Erie Street \* Chicago 10, Illinois

Branch Offices:

1063 Colorado Blvd., Los Angeles 41, California  
18407 Georgia Ave., Silver Spring, Maryland

Cable Address:  
Ariob, New York

Export Department:  
13 E. 49th Street, New York 16, N.Y.



- Scaling Units for Every Type of Radiation Counting
- Complete "Packaged" Counting Systems
- Health Monitoring Instruments for Personnel Protection
- Complete Line of Accessories for the Nuclear Laboratory
- Glass Wall, Mica Window, and Windowless Counters
- Portable Count Rate Meters
- Radioactive Chemicals

nuclear "PRECISION INSTRUMENTATION FOR NUCLEAR MEASUREMENTS"

# APPLICATION FOR HOTEL RESERVATIONS

## 119th AAAS MEETING

St. Louis, Mo., December 26-31, 1952

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in St. Louis. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in St. Louis and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. Share a room with a colleague if you wish to keep down expenses. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, as well as date and approximate hour of departure.

### HOTELS AND RATES PER DAY

Hotel*	Single	Double Bed	Twin Beds	Suites
CHASE	6.00- 9.00	8.00-10.00	8.00-12.00	14.00-30.00
DESOTO★D	4.00- 6.00	6.00- 9.00	7.50-14.00	11.50-22.00
JEFFERSON★D	4.50- 8.50	7.50-11.00	8.50-11.50	19.00-30.00
LENNOX D	5.00- 7.00	6.50- 9.00	8.50- 9.50	13.00 & up
MAJESTIC D	3.25- 4.50	5.25- 6.25	7.00- 8.00	10.00-15.00
MARK TWAIN D	4.50- 6.50	6.00- 8.50	8.50- 9.50	16.00 & up
MAYFAIR D	4.00- 7.00	5.50- 8.00	8.00-12.00	15.00 & up
MELBOURNE	4.50- 8.00	6.50- 8.50	8.50-11.00	17.00-25.00
ROOSEVELT		Reserved for mathematicians, \$2.75 to \$3.75 per bed.		
SHERATON	5.25- 8.85	8.00-11.00	9.00-12.50	11.00-30.00
STATLER★D	4.00- 7.00	6.50- 9.50	7.50-11.00	21.50-26.50

\* Hotels starred have sessions in their public rooms. For a list of the headquarters of each participating society and section, please see Association Affairs, *Science*, July 25, or *The Scientific Monthly*, August.

D = downtown hotel; the other hotels (not downtown) are for the mathematicians primarily.

### ----- THIS IS YOUR HOTEL RESERVATION COUPON -----

AAAS Housing Bureau  
Room 406-911 Locust St.  
St. Louis 1, Mo.

Date of Application .....

Please reserve the following accommodations for the 119th Meeting of the AAAS in St. Louis, Dec. 26-31, 1952:

#### TYPE OF ACCOMMODATION DESIRED

Single Room .....	Desired Rate .....	Maximum Rate .....	
Double-Bedded Room .....	Desired Rate .....	Maximum Rate .....	Number in party .....
Twin-Bedded Room .....	Desired Rate .....	Maximum Rate .....	
Suite .....	Desired Rate .....	Maximum Rate .....	Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....  
First Choice Hotel ..... Second Choice Hotel ..... Third Choice Hotel .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....  
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....  
(Individual requesting reservation) ..... (Please print or type)

ADDRESS .....  
(Street) ..... (City and Zone) ..... (State)

Mail this now to the Housing Bureau. Rooms will be assigned and confirmed in order of receipt of reservation.

# What GENERAL ELECTRIC People Are Saying

*The men whose statements appear below are engaged in research and development work on various types of control in G.E.'s General Engineering Laboratory at Schenectady, N. Y.*

## J. G. HUTTON

**PLANT CONTROL:** The control of processes by remote and automatic means may be said to have had its beginning with the birth of the electron tube and hence the electronics industry. The almost instantaneous receipt of an electric signal, even at a considerable distance from its source, and the ease with which many physical and chemical changes can be converted into electrical impulses, opened the way for automatic control even in the most complicated processes.

In the petroleum and chemical industries many attempts have been made in recent years to provide new and improved methods for determining accurately both qualitatively and quantitatively the composition of mixtures in either gaseous or liquid form.

Perhaps the most versatile, and as a result, the most useful of the methods, is that based on the principle that certain materials selectively absorb infrared radiation. By comparing an unknown mixture against a standard, analyses can be made. In the case of hydrocarbon mixtures the technique can not be extended beyond those containing six or more carbon atoms, however.

The mass spectrometer in contrast can be used for the analysis of most mixtures whose components are fully vaporized at a pressure of some 40 microns at normal temperature. Its range of usefulness may be extended by heating the sample introduction system, the upper temperature being limited only by the thermal properties of the material of the system. By this relatively simple expedient, hydrocarbon mixtures containing components with 40 carbon atoms have been analyzed. Except for the high initial cost, delicacy and bulk, the mass spectrometer would be directly useful for process control.

Such objections may be overcome by the use of a mass spectrometer utilizing the cyclotron resonance principle. The tube is positioned in a uniform d-c magnetic field and an rf voltage applied to suitable electrodes to produce a periodically varying electric field whose axis is perpendicular to the magnetic field. Ions are produced in the analyzer region of the tube by bombardment of neutral gas molecules with an electron beam whose axis is coincident with

the magnetic field. Under the influence of the combined electric and magnetic fields, the ions are accelerated and have an orbit of increasing radius—an Archimedes spiral. When the natural period of an ion of given mass is equal to the periodicity of the electric field, the particle assumes a resonant condition and acquires sufficient radial displacement to be absorbed or collected by a suitably placed electrode. Particles of different mass, having a different natural period, will not resonate. As a result such particles will be out of phase with the electric field and will not gain sufficient energy to reach the collector. By varying the electric or magnetic fields, or both, ions, representative of all molecules in a gaseous mixture, may be separated and collected,

## F. E. CREVER

**BIT WEIGHT CONTROL:** The improvements in control components and techniques of analyzing control systems in the past decade have made precise control of power equipment practical for industry generally. It is no longer considered sufficient to provide power equipment to augment man's efforts; rather, the convenience of automatic and precise control is often desired. Typical of this trend is the General Electric automatic bit weight control for rotary drilling. Not only does the system provide a means of handling the hundreds of thousands of pounds of piping, but also it provides an automatic system to regulate the weight on the bit and to limit the speed of the lowering of the bit. This is provided through two simple settings of the quantities involved on knobs provided for the operator. The system utilizes the regulating properties of the amplidyne generator controlling power equipment to perform these functions. More recently amplistats have been developed so that the advantages of static regulating equipment are being applied to the many control applications necessary to continued progress in industry.

*You can put your confidence in*  
**GENERAL  ELECTRIC**

# *More* MICROSCOPY PER STUDENT PER CLASS HOUR



• Exclusive time-saving features of the Bausch & Lomb "FL" Student Microscope help you solve the problems posed by overcrowding in today's science classes. More students can use the microscope in a limited time—with greater educational benefits—thanks to B&L advantages like these:

## INSTANTANEOUS FOCUS



Pre-focusing gage eliminates time-wasting searching . . . quickly positions slides of any thickness in accurate focus.



## BALANCED LIGHT ON FULL FIELD

True images and quick recognition are assured by even, cool and constant lighting of the entire field by the new Opti-lume Integral Illuminator (interchangeable with standard mirror and fork).

Give your classes the many optical and mechanical advantages of the first full standard size microscope ever designed for student use. Prompt delivery, of course.

*Write* for a demonstration and literature to Bausch & Lomb Optical Co., 642-29 St. Paul St., Rochester 2, N.Y.



**BAUSCH & LOMB**



**MICROSCOPE**

# Systematic Analysis of Factors Determining Accuracy in Visual Tracking<sup>1</sup>

Robert S. Lincoln and Karl U. Smith

Department of Psychology, University of Wisconsin, Madison

**A** GOOD PART OF EVERYDAY BEHAVIOR of most people depends on the ability to do visual tracking. Moreover, the understanding of this behavior is today a central problem of human engineering, inasmuch as the study of visual-motor tracking typifies the requirements of analysis of the relations between human response and the design of machinery and equipment.

This study is an attempt to develop systematic experimental methods for the comprehensive investigation of the role of different factors in determining accuracy in tracking. Observations are described concerning the effects of the following factors on tracking precision: (a) the instrumental relations of the tracking motion, (b) the ratios of motion between hand controls and visual cursor, (c) learning in relation to different component movements in the tracking response, and (d) target characteristics.

## METHODS

Fig. 1 illustrates diagrammatically the main elements of an apparatus designed to control in a systematic way the factors of significance in determining precision in visual-motor tracking. The operator in this task adjusts a hand wheel or some equivalent device in order to move a cursor with reference to a target. The latter travels radially through a predetermined course approximately in the same plane as the point of the cursor.

The device shown in Fig. 1 consists of (1) a target-cursor display, (2) a hand-control system, (3) a universal tracking control system, (4) a target-course generator system, and (5) an error recording and summing device. The general nature and purposes of these components are described below.

1. *Target-cursor display.* The display is located about 1.3 m from the hand wheel. The target, mounted on a rotating disk, consists of a visual pattern that may be varied in size, color, and form. The outer edge of the disk is hidden by a stationary shield. The cursor is a narrow arm, the center of rotation of which is the same as the target disk. A cursor of a visual angle of 4 minutes in width is typically used. Parallax effects between target and cursor are eliminated, inasmuch as their planes of movement are almost the same. The

design of the target-cursor display permits wide variations in the visual characteristics of both these elements of the presentation.

2. *Hand-control system.* The manual control pictured in Fig. 1 is a hand wheel 18.4 cm in diameter. This system permits control of the cursor with either hand or with both hands simultaneously. In addition, the system provides for changing the physical characteristics of the hand control, as well as its inertia and damping. The manual control system is arranged to permit study of all the various bodily components and space dimensions of tracking motions.

3. *The universal tracking control.* The component labeled "Universal Tracking Control" is a device for changing the type of tracking to be performed by the operator. Three types of tracking are possible through the use of this instrument: direct, velocity, and aided tracking. Fig. 2 illustrates the principles underlying these three types. In direct tracking, two component motions are used to position the cursor and change its rate of movement with respect to the target. In velocity tracking, the operator controls the cursor entirely through adjustment of the direction of rotation and the speed of a motor shaft. In aided tracking, direct positioning of the cursor is possible, and in addition the rate of movement of the cursor is controlled through a motor system. There are three basic differences between the different types. Different components of motion are used, and distinct translations and transformations of these motion components occur in each type. Finally, in aided tracking, complex mechanical differentiation and integration of a single basic positioning movement occur.

The universal tracking control picture in Fig. 1 mechanizes all three types of tracking control diagrammed in Fig. 2. Thus, by means of this device, it is possible to study under comparable conditions some of the different types of tracking used in modern machinery.

4. *Target generator system.* The target generator system consists of a ball-and-disk drive actuated by a constant-speed motor and controlled by means of a motor-driven cam that determines the target course. Variable target courses may be obtained by substituting one cam for another. In the studies reported here, a target course involving nine reversals of direction of movement with continuously changing velocity and magnitude of movement in each phase has been used.

5. *The error recording system.* Error recording in

<sup>1</sup> The research described in this paper has been carried out through funds voted by the State Legislature of Wisconsin and assigned by the Graduate School Research Committee, the University of Wisconsin.

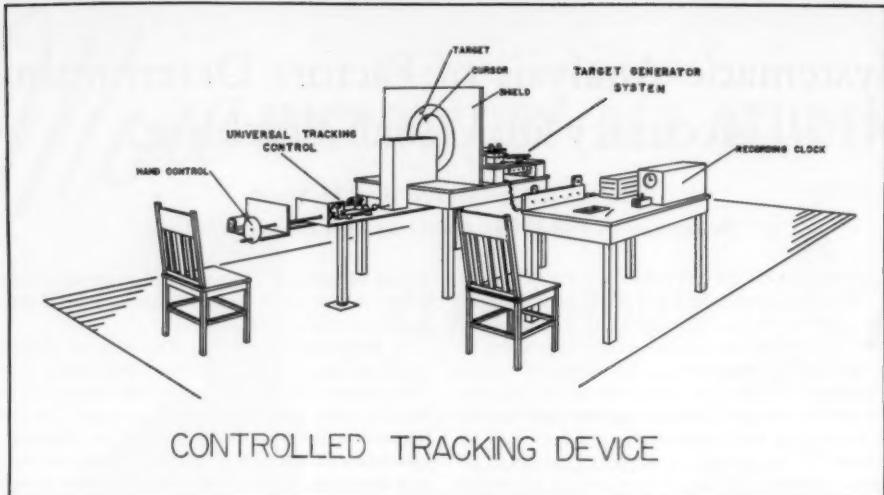


FIG. 1. The components of a preplanned performance situation for analysis of visual motor tracking.

this instrument is accomplished by means of an especially designed differential that continuously compares target and cursor position. The output of the target generator system drives the field of a precision selsyn that is attached to the center of the target disk, and the controlled cursor moves with the shaft of that same selsyn. The generated signal from this selsyn drives a receiver selsyn. The output of the receiver is employed to obtain a graphic error record, as well as an accuracy time score, that represents an integration of both frequency and magnitude of error.

In general, the apparatus described here has been developed to provide quantitative variation and experimental control of all the discrete factors of motor response and visual presentation concerned in tracking motions. In particular, this device makes possible the analytic study of separate body components of motion, of different space patterns of motion as utilized on various types of manual control, of separate component movements in tracking, and of different types of translations, transformations, and physical integrations of human motion used in modern remote-control machinery.

#### EXPERIMENTS

**1. Precision in different types of tracking.** Fig. 3 illustrates the nature of learning in direct, velocity, and aided tracking. These results show that proficiency in direct tracking is superior at all stages of practice to either velocity or aided tracking. The degree of change that is due to learning is greatest for the velocity tracking. In obtaining the data shown, optimal displacement ratios between the hand wheel and cursor were used for all three types of tracking. These ratios were determined in separate observations. In addition, the aided tracking ratio was set at 0.5

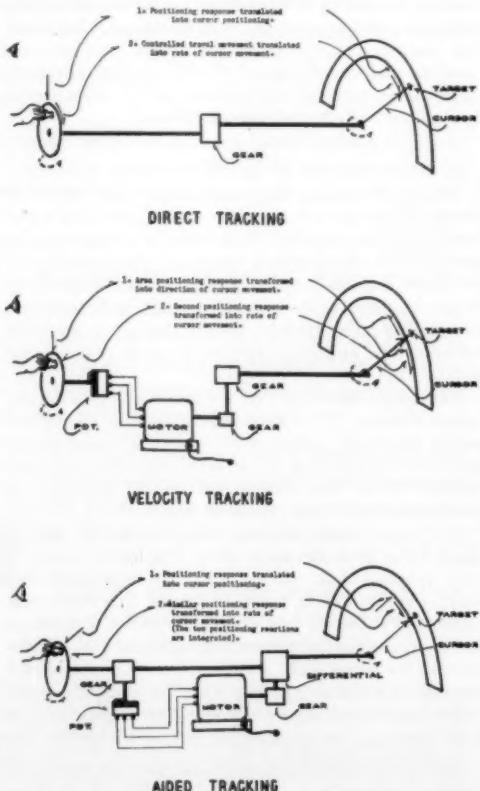


FIG. 2. Types of visual pursuit tracking.

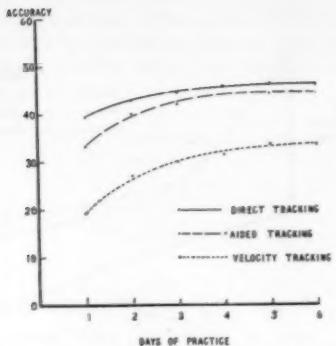


FIG. 3. Accuracy in different types of visual tracking as a function of practice. The accuracy level represents a time score integrating magnitude and frequency of error. These curves are based upon study of three groups of subjects, 18 subjects to the group. Subjects were randomly assigned to the groups.

seconds, a value that has been generally determined to be the optimal ratio for different types of equipment. This value is the one typically built into all modern aided tracking devices. Over all, the results presented here mean that, in the tracking of complex courses, the common types of aiding devices constitute no real general aid to the operator. This statement may not cover special situations in tracking, such as aerial gunnery, etc., in which target course is extremely uniform in direction, and in which rate control, especially that provided by aided tracking, may simplify a component aspect of the tracking problem. But such possibilities require more specific study.

It may be of significance to note that the degree of accuracy is related to the extent to which the manual

motion is instrumentally modified in the different types of tracking. In direct tracking manual motion is translated proportionately into cursor motion. This type is most accurate. In aided tracking, one of the translations of direct tracking is retained, but there occurs a transformation of the prime positioning motion with respect to the cursor. Aided tracking is next in accuracy. Finally, velocity tracking involves a complete transformation of all components of the performed motion and is the least accurate of the three types. The effects of practice do not overcome the basic differences in precision occurring in these different types.

2. *Optimal ratios between hand wheel and cursor motion for different types of tracking.* Fig. 4 describes the level of tracking accuracy as a function of the ratios of motion between target and cursor. For direct and aided tracking the ratios indicated represent the unit displacement of hand wheel relative to unit displacement of the cursor. For the velocity tracking, the ratios represent the increment in velocity of cursor movement per degree of hand wheel rotation. The data for aided tracking apply to both component elements of the system, but the figures are given in terms of the ratio for the positioning component.

The results cited are considered preliminary in defining the instrumental relations of the different types of tracking. Data on the velocity tracking are held to be very tentative, mainly because the optimal value changes in relation to training, and the value found is not particularly decisive in its own right. The data show, however, that optimal instrumental relations vary for different types. The experiments also indicate an important psychological aspect of human instrumentation research; namely, the necessity for establishing optimum conditions for different operational

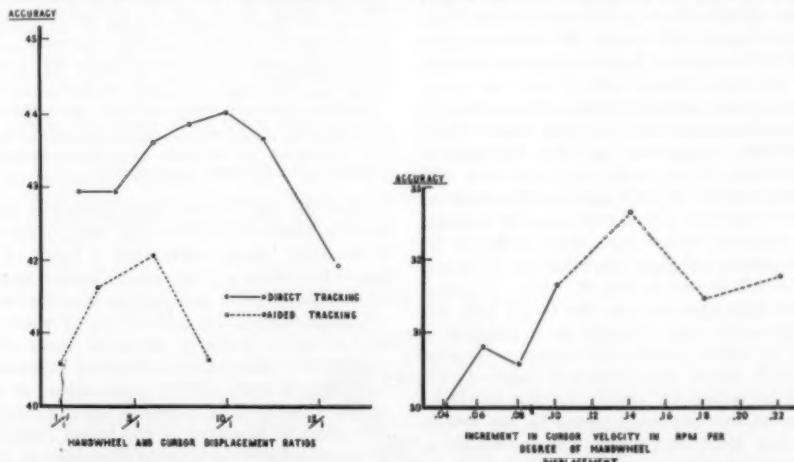


FIG. 4. Optimum ratios of motion between hand wheel and cursor for different types of tracking. The curves for direct and aided tracking are based on two groups of subjects, eight subjects for direct tracking and four for aided tracking. The curve for velocity tracking is based upon two groups of subjects, four to the group. One group tracked the lower ratios, and the other group the higher. The value .10 rpm was common to both groups. The two curves were adjusted in height in order to correct for sampling differences and for differences in practice of the two groups.

functions before these functions can be compared.

### 3. Effect of learning on component movements.<sup>2</sup>

The motor pattern in direct tracking is not a uniform single response. In reactive terms, it is made up primarily of two components, a rapidly oscillating positioning motion and a travel motion of longer wavelength that controls rate of cursor movement. Analysis of these components is fundamental to all aspects of understanding the behavior concerned.

In Fig. 5 are shown results bearing upon the effects of learning on different component movements in direct tracking. These curves represent the change in occurrence of response components of different wavelengths as a function of practice. The short wavelengths represent, for the most part, positioning error. The long wavelengths represent mainly rate error. The intermediate curves probably represent a mixture of both components of motion. The curves themselves describe how frequently these different component movements involving error appear with successive days of practice.

Reference to Fig. 5 will show that practice affects mainly the most rapid positioning movements. These error motions are reduced fairly sharply as practice continues. The longer wavelength, rate-control movements of direct tracking seem to display no change in frequency as a function of practice.

Fig. 5 also summarizes the change in occurrence of the different motion components in relation to three different target speeds. The greatest learning change in positioning motions occurs for the fastest and intermediate target speeds.

4. Effect of target characteristics. It is generally thought—and this belief is expressed in terms of current designs of cursor and reticle elements in tracking devices—that accuracy in tracking is related closely to the degree of refinement in size and contour cues provided by the target and cursor. We can investigate this problem of perceptual discrimination in tracking in one way by varying target size.

Fig. 6 shows the change in over-all accuracy in direct tracking as a function of target width. There is relatively little change over a width variation of some thirty times. These results were obtained with an overlapping cursor. In some observations made on this problem it has been found that the most accurate tracking is obtained with target sizes exceeding the width of the cursor, although this effect is not clearly seen in the results shown in Fig. 6.

The results just cited are not due to the fact that the error tolerances were changed as a function of target size. In these studies, the accuracy requirements for each target size remained constant. The subject had to center his cursor on the target no matter what its size happened to be. In the investigations on this point, target size was varied by inserting patterns of different radial extent in a special mount on the target disk.

<sup>2</sup>This part of the study was aided by the work of Richard Simon and Thurlow Weed De Crow in the analysis of record data.

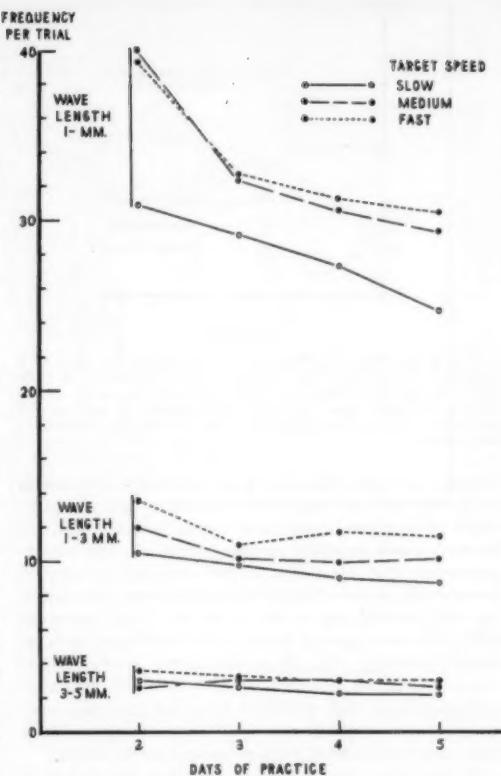


FIG. 5. Frequency of error responses in direct tracking for different target speeds and for wavelength categories as a function of practice. Target speed is designated as slow, medium, and fast. These represent, respectively, motor speeds of the target generator system of 23, 30, and 37 rpm. Because the target course is variable, it is not possible to describe target speed in terms of actual velocity of the target. For obtaining counts of wavelengths of error movements, the recording tape moved at the rate of 5.0 cm/min. Each trial was 1 min in length. Three groups of subjects were used in the experiment, 12 subjects to a group. Separate groups tracked at the different target speeds.

With the use of both overlapping and vernier-type cursors, observations have also been made on effects of changing target width over a range of some ten times the value of the most limited target width. Within these limits, accuracy in tracking does not decline significantly for either type of visual presentation as target width is increased. Such observations suggest that perception in tracking involves discrimination based upon pattern organization of target and cursor. The specific psychophysical function is one of scaling or bisecting of the target rather than one of reaction based on specific alignment of contours.

One of the most decisive perceptual factors determining precision in tracking is the velocity of the target to be tracked. This fact has already been indicated visually in Fig. 5. No other mode of change in

the visual presentation, unless it be radical in nature, alters accuracy in tracking as much as target velocity. Furthermore, practice effects do not obliterate the

sions of human motion in the task may be quantitatively varied and specified for experimental investigation.

2) It has been established that accuracy of performance is greater and the degree of learning is less in direct tracking than in types of tracking in which some aid is provided to the operator. These differences in direct, velocity, and aided tracking may be accounted for in terms of the extent to which the performed tracking motion is modified by the tracking device in producing movements of the observed cursor.

3) The comparison of the different types of tracking devices and of other types of machines in relation to their adequacy for human use involves more than observation of general performance on such equipment. Before comparisons can be made in a meaningful manner, the optimum conditions of translations, transformations, and integrations of performed motion by the different devices must be known. The determination of optimum ratios between manual motion and cursor motion for different types of tracking has been indicated.

4) The positioning and rate control components of tracking motions are affected quite differently by factors determining accuracy in tracking. The learning effects on frequency of error in direct tracking occur almost entirely in the positioning components of the motion. There are no general laws of learning of significance in describing various concrete phenomena of visual-motor tracking.

5) Study of the visual display in direct tracking discloses that the specific psychophysical function of pursuit tracking is one of scaling the target by means of the controlled cursor rather than a function of alignment of target and cursor contours. Target velocity is the prime visual variation of significance in determining error in this behavior.

In general, the present study suggests that a dimensional conception of motion providing for concrete specification and analysis of the components and dimensions of behavior represents a constructive quantitative approach to problems of human engineering and is to be contrasted to efforts to advance this field through generalized theories and analogies supposedly covering all phenomena of human response.

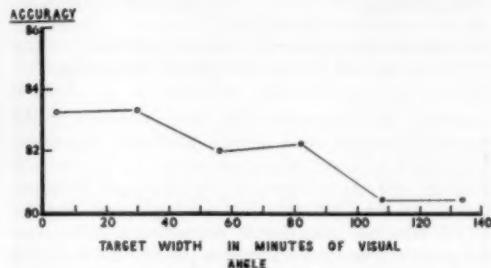


FIG. 6. Accuracy in direct tracking as a function of target width. Seventeen trained subjects were used in the experiment, and all subjects tracked all different target widths.

fundamental differences in precision related to the speed of the target. As shown in Fig. 5, the frequency of error movements, especially the positioning movements, is directly related to target velocity. So is the magnitude of these movements.

#### SUMMARY

The experimental study of visual-motor tracking exemplifies the requirements of systematic analysis that are necessary for understanding many different types of human response and work.

We may systematize the specification of motor behavior for investigation of problems in psychology and human engineering by reference to (1) the reactive components of motion and (2) the different dimensions of motion. Study of the physical and physiological factors determining human motion, as well as measurement of the effects of growth, learning, fatigue, and other dynamic aspects of response on motion, may be carried out in a meaningful way when the basic components and dimensions of a pattern of motion are known and controlled. Dimensional analysis of tracking motions has brought out the following main facts:

1) By the use of appropriate devices it is possible to develop preplanned performance situations in which all the main reactive components and dimen-



## News and Notes

### International Union of Biological Sciences

THE Executive Committee of the International Union of Biological Sciences (IUBS) met in London March 4-5, for the first time since the last General Assembly of IUBS in 1950 in Copenhagen. Thirty scientists represented the nine sections of the union under the presidency of H. Munro Fox. Of the various presentations and discussions, certain decisions or suggestions deserve mention:

Three delegates have been designated to represent IUBS on the new Inter-Union Commission for Electron Microscopy. The function of this commission is principally to arrange international colloquia and/or congresses on electron microscopy and its applications. The delegates from IUBS are (Miss) I. Manton, professor of botany, University of Leeds; J. Weigle, of the Institute of Physics, University of Geneva; and Francis O. Schmitt, of Massachusetts Institute of Technology. The secretary general of the commission is F. W. Cuckow, Chester Beatty Institute, Royal Cancer Hospital, Fulham Road, London, S. W. 3. Ralph W. G. Wyckoff, of the National Institutes of Health, Bethesda, Md., has been appointed to the commission as representative of the Union of Crystallography. Representatives of the International Union of Pure and Applied Chemistry and of the International Union of Pure and Applied Physics have yet to be appointed.

A motion was adopted recommending that substantial financial aid be sought from international foundations for scientific components of IUBS, and in particular for two centers of taxonomy and of experimental research, created by the commission to investigate biological control of plant pests.

A second action, important for the scientific life of the union, was taken, recommending the creation of scientific sections in special disciplines identical with the corresponding organizations in the same disciplines, to the end that coordination of aims and activities may be achieved. Examples of such identifications currently in existence are the International Association of Microbiologists, constituted as the Section of Microbiology of IUBS; the Biometric Society, now the Section of Biometry of IUBS; and the Society for Cell Biology, which is the Section of Experimental Cytology of IUBS.

The value of the colloquia organized by the union, it was emphasized, must be measured in terms of international cooperation and their contribution to science. In 1951, "Cytochemistry" at London and at Stockholm, "Symbiosis among Insects" at Amsterdam, and problems of "Biometry in Relation to the Growth of Plants" at Calcutta were the topics of stimulating and fruitful meetings.

There have been prepared for 1952 four colloquia on the following subjects:

"Bacteriophage" Royaumont (near Paris)  
"Cyto- and Histodifferentiation" Stockholm  
"Scientific Organization of Botanical Gardens" London  
"Biochemical and Structural Bases of Morphology" Utrecht

Among the suggestions that were proposed by the members present, one merits particular attention. Developed by Paul Weiss, chairman of Division of Biology and Agriculture of the National Research Council of the USA, this involved a proposal that the IUBS take the initiative in convening a colloquium designed to define the orientation that the union should adopt in relation to the needs and aims of biology.

P. VAYSSIÈRE, *Secretary General, IUBS*  
STUART MUDD, *Secretary*

### Scientists in the News

Archie Blake, of the Mechanical Research Corporation, Chicago, will be head of the International Business Machines Computing Section of the Cornell Aeronautical Laboratory, Buffalo, N. Y.

John W. Brice, who joined the Standard Oil Company (New Jersey) in 1926 as a geologist, has been elected president of the Carter Oil Company, a wholly owned subsidiary. He succeeds O. C. Schorp, who is retiring from active duty with the company.

Maxwell Dauer, chief of the Special Projects Branch of the Army Medical Research and Development Board, has been awarded an associate fellowship in the American College of Radiology. He is the first Army Medical Service Corps officer to be given the honor. Colonel Dauer served during World War II on the staff of atomic physicists assigned to the Manhattan District. He also was commanding officer of the now defunct Army School of Roentgenology in Washington during the early part of the war.

T. H. Dunkelberger has assumed his duties as professor of chemistry and administrative officer of the Chemistry Department at the University of Pittsburgh. He was formerly professor and head of the Chemistry Department at Duquesne University.

Austin Manindra Nath Ghosh, superintending geologist in the Geological Survey of India, is engaged in a three-month study of mineralogical and petrological research and educational centers in the U. S. Mr. Ghosh has been employed in the Geological Survey of India since September 1924, and as superintending geologist, supervises the field work, both mapping and mineral investigations, of the officers of the Eastern and North Eastern circles, engaged in a special study of the zones of progressive metamorphism in the Sikkim Himalaya. Also in this country

for an equal period is **Mulk Raj Sahni**, who will carry out research at the USGS and visit museums and educational centers. He was appointed assistant superintendent, Geological Survey of India in 1929, and is now superintending geologist in charge, Northern Circle. Mr. Sahni, founder-president of the Paleontological Society of India, is especially interested in invertebrate paleontology and stratigraphy.

**P. Hariharan**, of the National Physical Laboratory, New Delhi, is now attached to the National Research Council of Canada Division of Physics as the first research fellow under the Colombo Plan.

Harvard Medical School recently announced the appointment of **Arthur T. Hertig** as Shattuck professor of pathological anatomy, to succeed **S. Burt Wolbach**, who occupied this professorship from 1922 until his retirement in 1947. Dr. Hertig is pathologist and senior obstetrician at the Boston Lying-In Hospital and pathologist at the Free Hospital for Women. **Paul C. Zamecnik** has been appointed assistant professor of medicine at the Massachusetts General Hospital, where he has been serving as associate physician. He is also associate physician at the Homberg Infirmary of the Massachusetts Institute of Technology, and scientific consultant to the Beverly Hospital Research Foundation.

**Charles E. Kellogg**, chief of the Soil Survey Division, ARA, and vice president and chairman of the Section on Agriculture, AAAS, was honored at the New Zealand Embassy when he was presented with a carved Maori box. The gift, from a group of soil scientists in New Zealand, was in recognition of Dr. Kellogg's interest and help to soil scientists of that country.

**Vern O. Knudsen**, dean of the Graduate Division and chairman of the Administrative Committee on the Los Angeles campus of the University of California, is visiting Europe and the Near and Middle East. While in Europe, Dr. Knudsen will investigate the acoustics of the Royal Festival Concert Hall in London and the Roman theaters in southern France. He will also visit the American University at Beirut to study the possibility of establishing a curricula of Near and Middle East studies at UCLA.

**L. Jackson Laslett** has been granted a year's leave of absence from the Ames Laboratory of the Atomic Energy Commission and Department of Physics, Iowa State College, to assume the duties of branch head in the Nuclear Physics Branch of the Office of Naval Research.

**Walter Leighton** and **Simon H. Herzfeld** were recently appointed consultants for the Office of Scientific Research of the Air Research and Development Command at Baltimore, Md. Dr. Leighton is on leave from his position as chairman of the Department of Mathematics at Washington University. Dr. Herzfeld, who has joined the OSR Chemistry Division,

was until recently at the University of Chicago, where he conducted research in synthetic rubber for the Office of Rubber Research, RFC.

**Lawrence Litchfield, Jr.**, has been elected president of Alcoa Mining Company, New York City, and of Surinaamsche Bauxite Maatschappij, Paramaribo, Suriname, both subsidiaries of Aluminum Company of America. He succeeds **Frank B. Cuff**, who has retired. Mr. Litchfield, who has been serving as vice president, has had 27 years' service with the company. Mr. Litchfield is also president and director of Alcoa Exploration Company. Mr. Cuff, born in Manchester, England, joined Republic Mining and Manufacturing Company (now Alcoa Mining Company) and Surinaamsche Bauxite Maatschappij in 1916 as accountant. He subsequently was treasurer, vice president, and president of both companies, attaining the latter position in 1937. In recognition of Mr. Cuff's interest in and contribution to the development and progress of Suriname, he was decorated in May by Queen Juliana of Holland, being made an officer in the order of Oranje-Nassau.

**W. T. Marshall**, professor of engineering in the University of St. Andrews since 1946, has been appointed regius professor of civil engineering in the University of Glasgow, succeeding the late **Gilbert Cook**.

**David A. Munro**, who until recently was a practicing veterinarian, has joined the West Virginia University faculty as an assistant professor and assistant animal pathologist. A graduate of Ontario Veterinary College, he formerly was employed by the Health of Animals Branch of the Dominion of Canada.

**Julian S. Nichols**, a senior in physics at West Virginia University, is the first winner of a scholarship established last spring by the Radio Corporation of America in honor of its vice president and technical director, Charles B. Jolliffe. Dr. Jolliffe is a native West Virginian and a university alumnus.

**James R. Shaw** has been appointed chief, Division of Hospitals, USPHS. Formerly medical officer in charge of the USPHS Hospital, Detroit, Dr. Shaw succeeds **G. Halsey Hunt**, who was recently named associate chief, Bureau of Medical Services. As chief of the Division of Hospitals, Dr. Shaw will have charge of the 22 hospitals, 19 out-patient clinics, and over 100 out-patient offices operated for the beneficiaries of the Public Health Service.

**Hardy L. Shirley**, of Syracuse, has been appointed dean of the State University of New York's College of Forestry at Syracuse. He has been acting dean since Jan. 1 and previously was assistant dean. His predecessor, **Joseph S. Illick**, has been named dean emeritus. He headed the college for six years, beginning in 1945.

At the Harvard School of Dental Medicine **Reidar F. Sognnaes**, associate dean, has been appointed

Charles A. Brackett professor of oral pathology, succeeding **Kurt Thoma**, who retired in 1950. Dr. Sognnae also serves as consultant to the Forsyth Dental Infirmary for Children, and to the National Institute for Dental Research, USPHS. **David Weisberger** has been appointed professor of dental medicine. He will continue his clinical practice as oral surgeon and chief of the Dental Service at Massachusetts General Hospital, and as associate stomatologist of the Children's Hospital in Boston.

**Paul Ward**, holder of the University of Wisconsin Science Writing Internship 1951-52, has joined the staff of the U. S. Department of Agriculture's Bureau of Agricultural and Industrial Chemistry in Washington, where he will work under F. L. Teuton in the Information Division. The UW Science Writing Internship, a joint project of the Graduate School and the University News Service, is the only program for science writing training of its type in the country.

**Jerome B. Wiesner**, professor of electrical engineering and associate director of the Research Laboratory of Electronics at Massachusetts Institute of Technology, has been appointed director of the laboratory. He succeeds **Albert G. Hill**, who is on leave of absence from the department of physics, and who has been appointed director of the Lincoln Laboratory, an electronic research project operated by MIT for the Department of Defense.

**Charles G. Wilber**, formerly of St. Louis University, has joined the Chemical Corps Medical Laboratories at the Army Chemical Center, Md. Dr. Wilber has led five expeditions into the Arctic in his research on the physiology of men and animals in the polar regions, four of them under the sponsorship of the Arctic Institute of North America while he served as director of St. Louis University's biological laboratories. Dr. Wilber has been studying arctic problems ranging from the general physiology of arctic animals to advising on diets and clothing for American troops who are or will be stationed in arctic regions.

## Education

The University of Illinois and Allahabad Agricultural Institute, supported by TCA and Ford Foundation funds, will exchange staff members annually, beginning this fall. Major emphasis will be given to agriculture and home economics, but other subjects may also receive attention. H. C. M. Case is director of the program.

The University of Michigan and the University of the Philippines, financed by MSA funds, will co-operate in the establishment of an Institute of Public Administration. John Lederle, director of Michigan's own institute, has gone to Manila to start organizing the program. Instructors will be furnished by the University of Michigan and other educational institutions.

New York University will offer the M.Sc. degree in metallurgy for the first time with the opening of the 1952-53 academic year. The curriculum will stress metals technology and physical metallurgy and will include courses in x-ray metallography, electron theory of metals, laboratory techniques, and alloys for special temperature conditions. John P. Nielson will direct the program and a staff consisting of Irving B. Cadoff, Harold Margolin, and Polystarp Herasymenko. Adjunct professors from industry will be Fred D. Rosi and Leslie L. Seigle, of Sylvania Electric Products; Claus G. Goetzl, of Sintercast Corporation; and Morris E. Fine, of Bell Telephone Laboratories.

Northwestern University will sponsor a series of lectures during the fall quarter on "The Organic Chemistry of Natural Products" on Tuesday evenings in Lincoln Hall, on the Chicago campus. Beginning Sept. 30, the speakers will be Max Tishler, George C. Harris, Bernard Witkop, Louis F. Fieser, Robert B. Angier, F. Sanger (2 lectures), Robert W. Woodward, Marshall Gates, and Nelson Leonard. Inquiries may be addressed to the office of the University College, 339 E. Chicago Ave., Chicago 11, or to V. Georgian, Department of Chemistry, Evanston.

## Grants and Fellowships

A Louis Bothman Fellowship in Ocular Pathology has been established at the University of Illinois College of Medicine, with funds received from Phi Delta Epsilon. The late Dr. Bothman was clinical professor of ophthalmology at the university.

The California Planting Cotton Seed Distributors have awarded \$10,000 to the University of California to supplement a previous grant supporting the work of Frederick T. Addicott, associate professor of botany. Dr. Addicott's work is concerned mainly with chemical defoliation, but is also devoted to field conditions affecting defoliation.

General Motors Corporation has established a graduate fellowship in electrochemistry in the University of Michigan Department of Chemistry. It provides a cash award of \$1800 to the holder and \$1000 to the university; the recipient will be nominated by the department faculty.

Merck & Co. Limited postdoctoral fellowships in the natural sciences have been awarded to S. G. A. Alivisatos, who will study enzyme systems at Bellevue under S. Ochoa; K. K. Carroll, who will study potato eelworms at the University of Cambridge, under A. R. Todd; and R. L. Kay, who will study the properties of electrolytic solutions at the Rockefeller Institute, under D. MacInnes.

The National Multiple Sclerosis Society has made five research grants totaling \$28,000 for projects dealing with relatively unexplored fields of basic research. Studies will be carried on at the University of Rochester Medical Center; the University of California

and the Langley Porter Clinic, San Francisco; the Jewish Sanitarium and Hospital for Chronic Disease, Brooklyn; the University of Miami; and the Neurological University Clinic, Hamburg-Eppendorf, Germany.

**Parke, Davis & Company** is the donor of a new multiple fellowship at Mellon Institute. The fellowship will carry on long-range investigations in synthetic organic chemistry and is headed by Alexander M. Moore, of Parke, Davis. The **Philadelphia and Reading Coal and Iron Company** has resumed its research at the institute with the operation of a new fellowship on the problems of production, preparation, transportation, marketing, and utilization of anthracite, both as a fuel and as a source of chemicals. James H. Black has been appointed to do the research.

**Playtex Park Research Institute** has renewed its grant to the Roscoe B. Jackson Memorial Laboratory for a continuation of the studies of Paul Sawin on mice and rabbits with neuromuscular abnormalities.

For the second quarter of 1952 the **Rockefeller Foundation** and **General Education Board** have made grants totaling about \$10,000,000 for educational and scientific research programs. Largest amount was \$2,000,000, given to the National Bureau of Economic Research, in lieu of further grants for general support of the bureau, which has already received more than \$5,000,000 from the foundation and the Laura Spelman Rockefeller Memorial. Other large grants were \$100,000 to McLean Hospital, an affiliate of Massachusetts General Hospital, for support of research in brain chemistry; three grants totaling \$121,000 to the University of California; \$150,000 to the Allahabad (India) Agricultural Institute; \$142,800 to Keio University, Tokyo, for the further development of the Japan Library School; \$100,000 to the National Research Council toward the expenses of the Commission on Human Resources and Advanced Training, under the direction of Dael Wolfle. Grants were also made for purchase of research equipment, assistance to individuals, or travel in various countries.

## In the Laboratories

A new **Arthritis Laboratory**, devoted to research in rheumatology, has been organized in the Boston Dispensary, a unit of the New England Medical Center, Boston, by Tufts College Medical School. It will supplement the Arthritis Clinic and the recently organized Tufts Arthritis Service at Holy Ghost Hospital, Cambridge, Mass. Edward H. Frieden, of the Harvard Biological Laboratories, has been appointed chief biochemist.

**Bjorksten Research Laboratories** have established an office in Washington, D. C., under the direction of James W. Perry, past chairman of the American Chemical Society Division of Literature Chemistry. The new office will function principally as a center

for literature research in the libraries of the Patent Office, the Library of Congress, and other Washington depositories.

The **Jena Glass Works Schott & Gen.**, aided by capital from the U. S. under the Marshall Plan, have erected a new plant near Mainz. The Jena plant was originally liberated by U. S. Armed Forces, and about 180 of the top personnel, evacuated to the Western Zone of Germany, have rebuilt and put into operation smaller plants there. It was from this nucleus that the new plant was built.

The new **Maritime Regional Laboratory** of the National Research Council of Canada, built on the campus of Dalhousie University, was officially opened June 16. At a Symposium on Scientific Research in the Maritime Provinces, J. H. L. Johnstone, C. W. Argue, H. D. Smith, S. A. Beatty, and J. Keyston spoke.

**Olin Industries, Inc.**, has announced the appointment of John J. O'Neill, Jr., as manager of the Research and Development Department of the Explosives Division.

## Meetings and Elections

The **American Academy for Cerebral Palsy** will hold its annual meeting in Durham, N. C., Oct. 2-4. Scientific sessions will be held at the Cerebral Palsy Hospital, Duke University, and will be open to all interested physicians.

The **American Association of Cereal Chemists** will hold its annual triection meeting at Kansas State College Oct. 10-11. The meeting will feature a symposium on the use of x-ray for wheat inspection and one on biological oxidation and reduction.

The **American Society for Quality Control** will hold its sixth New England Conference at the Sheraton Hotel, Worcester, Mass., Oct. 3-4. Manufacturing plants in the vicinity will be visited, and a variety of outstanding speakers will speak on the many phases of quality control.

A **Centennial Conference on Industrial Research** will be sponsored by Armour Research Foundation of Illinois Institute of Technology Sept. 9. Harry A. Winne, of General Electric, will speak at the conference luncheon and participate in an afternoon panel session, at which William A. Casler will act as moderator. James Shennan, of Elgin National Watch Company; Howard Turner, of Pittsburgh Consolidation Coal Company; and A. Allan Bates, of the Portland Cement Association, will also take part in the panel discussions.

An international conference on the **Epidemiology of Cancer of the Lung** was held in Louvain July 21-24, under the auspices of WHO, Unesco, the Committee on Geographical Pathology of the International Cancer Research Commission, and the Committee of the International Organization of Medical Sciences. Official U. S. representatives were Harold F. Dorn,

Cuyler Hammond, Morton Levin, William Smith, Harold L. Stewart, and Paul E. Steiner.

The Meteoritical Society will hold its 15th meeting at the Institute of Meteoritics of the University of New Mexico Sept. 2-4, at which time the new quarters of the institute in the recently completed Physics-Meteoritics Building will be dedicated.

The National Association of Science Writers has elected Volta Torrey, editor of *Popular Science Monthly*, president, and Arthur J. Snider, of the Chicago *Daily News*, vice president. Alton L. Blakeslee, of the Associated Press, was re-elected secretary-treasurer, and Herbert B. Nichols, USGS, continues as AAAS Council representative.

The New Zealand Soil Bureau has appointed Norman H. Taylor director, succeeding L. I. Grange, who has accepted a position as director of the Geological Survey. J. K. Dixon succeeds Mr. Taylor as assistant director. Both men were recent visitors to the U. S.

### Miscellaneous

The Academy of Natural Sciences, Philadelphia, announces the following appointments: Robert R. Harry, of the California Academy of Sciences, as assistant curator of fishes, and Harold W. Harry and Matthew H. Hohn, to the Department of Limnology.

Air Pollution Control Association is the new name of the Air Pollution and Smoke Prevention Association of America, Inc.

The Department of State has assigned William W. Greulich, of the Department of Anatomy, School of Medicine, Stanford University, and Richard T. Arnold, of the Department of Chemistry, University of Minnesota, to the Office of the U. S. High Commissioner for Germany at Bonn, to serve as science advisers. Harald H. Nielsen, of the Department of Physics, Ohio State, has been assigned as science attaché to the embassy at Stockholm, replacing Wm. L. Doyle, who will return to his post at the University of Chicago this fall after serving at the embassy since July 1951.

The Institute for Atomic Research, Iowa State College, has had the following visitors recently from abroad: E. P. George, of Birkbeck College, London University, who spoke at a special physics seminar; and Emile Pruvot, Raymond Chevigny, and Charles Roy, of Pechiney, the French aluminum trust, who participated in a seminar on Rare Earths and Unusual Metals.

The official U. S. delegates to the International Grassland Congress, being held at Pennsylvania State College this week, are Philip V. Cardon, William A. Minor, Mason H. Campbell, Wilbur G. Carlson, Leroy E. Hoffman, Malcolm H. Jones, Gerald M. Kerr, and Arthur S. King.

The new FAO David Lubin Memorial Library was formally opened in Rome June 10. Honor guests were

the children and the secretary of David Lubin, founder of the Institut International de l'Agriculture and of its library of some 350,000 publications, which now forms the most substantial part of the new library.

The National Bureau of Standards is setting up a comprehensive punch-card catalogue of all available data on the infrared spectra of organic and inorganic compounds, under the sponsorship of the National Research Council. The first cards, containing data on 45 compounds, are now being made available on a subscription basis. Data will be printed on key-sort cards, IBM cards, and letter-size paper. E. Carroll Creitz, of the bureau staff, is in charge of the compilation.

Under contract with the National Science Foundation, Columbia University has undertaken a series of studies expected to result in the compilation of a new, comprehensive Russian-English scientific dictionary. The foundation has allocated \$39,300 for a systematic survey of existing dictionaries, and development and testing of methods for compiling lists of words for which definitions are required. A steering committee consists of Ernest J. Simmons, Philip E. Mosely, I. I. Rabi, John Turkovich, and V. Rojansky. Dr. Rojansky, of the Department of Physics, Union College, will be on leave of absence to direct the project.

New journals received: *The British Journal of Delinquency*. Official organ of the Institute for the Study and Treatment of Delinquency. Quarterly; Vol. 1, No. 1, Oct. 1950. \$4.25 per year, from the institute, 8 Bourbon St., Davies St., London, W. 1. . . . *Building Research in Canada*. Division of Building Research, National Research Council, Ottawa, Canada. Vol. I, No. 1, June 30, 1951. . . . *Bulletin, Centre Roumain de Recherches* (French). Quarterly; Vol. I, No. 2, Feb. 1952 (mimeo.). 50¢ per copy, U.S. 28, rue Serpente, Paris 6. . . . *La Clinica Terapeutica* (Italian). Monthly; Vol. 2, No. 1, Jan. 1952. 3000 lire. Societa' Editrice Universo, Viale Università, N. 27, Rome. . . . *Czechoslovak Journal of Physics*. Vol. 1, No. 1, Oct. 1, 1952. Centre of Research and Technical Development-Central Institute of Physics, Prague. . . . *Hiroshima Journal of Medical Sciences*. Vol. 1, No. 1, Dec. 1951. Hiroshima Medical College, Aga-Machi, Kure-City. Hiroshima-Prefecture, Japan. . . . *The Indian Journal of Child Health*. Monthly; Vol. I, No. 3, March 1952. Rs. 15, foreign. The Association of Pediatricians of India, Back-Bay View, New Queen's Road, Bombay 4. . . . *Instrument Engineer*. Devoted to measurement and automatic control in industry. Semiannual; Vol. 1, No. 1, April 1952. 5s. per year. George Kent Ltd., Luton, Bedfordshire, Eng.

A revised and completely reset third edition of *The World List of Scientific Periodicals* lists more than 50,000 volumes, nearly 40 per cent more than the second edition, and includes titles of new journals published between 1930 and 1950. It is available at \$37.00 from Academic Press.

## Technical Papers

### Rapid Serial Recording of Concentrations in the Blood Circulation and in Perfusion Systems: The Effluogram<sup>1,2</sup>

James M. O'Brien and Walter S. Wilde

Department of Physiology,  
Tulane University, New Orleans, Louisiana

Recently we have attempted to relate in time the outflux of potassium from cardiac muscle to the phases of the contraction myogram and of the action potential. The heart of the intact heart is pre-equilibrated overnight against intraperitoneal  $K^{42}$ . The next morning the coronary artery and a vein of the excised heart are cannulated with polyethylene tubing. Nonradioactive Ringer's solution is perfused through the ventricle, which has been rendered quiescent by Stannius ligature. After the ventricle is cleared, by perfusion, of blood and interstitial  $K^{42}$ , etc., it is ready for stimulation by inductorium to demonstrate the possible release of radiopotassium into the outflowing Ringer. Such use of a radioisotope adds marked sensitivity to the analyses, but the changes still seem too fast and too feeble to record with a count rate meter placed over the heart or over an effluent vessel.

Instead, we lead the outflowing Ringer onto a strip of filter paper that moves past the cannula at a fast but known speed. Thus the chemical outflux is caught and stored on the strip for leisurely counting later, just as motion is caught on a motion picture film. The  $K^{42}$  may be counted later by moving the strip much more slowly past a count rate meter or by counting numbered segments cut from the paper strip. If it is desirable to record concentration—that is, to relate the  $K^{42}$  count to the volume of effluent perfusate that contained it—we add a known concentration of biologically inert indicator radioactivity to the perfusate. We have used tagged iodinated albumin and radio iodide in carrier NaI. The  $I^{131}$  count is then an indirect measure of the volume outflow associated with a given  $K^{42}$  count. The frequency of sampling is limited only by the magnitude of the radioactivity counts obtainable. Not only are samples frequent and small, but there is no wastage of fluid in the sample tubes while pipetting. Serial concentrations in animal blood from cannulated veins or arteries can be measured with a minimum of bleeding. We have recorded samples every 0.1 sec, representing equivalent volumes of 0.003 ml.

The effluogram shown in Fig. 1 was done with thin

<sup>1</sup> Work done under contract No. AT-(40-1)-1301 between the U. S. Atomic Energy Commission and Tulane University (W. S. Wilde).

<sup>2</sup> Isotopes allocated by the AEC. Authorization numbers 11,141 and 13,474.

filter paper mounted on blotting paper (we now use Eaton-Dikeman filter paper #320, which is about 2.5 mm thick). The strip was 1.6 cm wide and 51 cm long. A band of Scotch tape was laid along the bottom and folded over the edges of the strip to make it watertight except for the upper surface. The strip was mounted snugly on a horizontal kymograph drum which moved the strip past the effluent cannula at a rate of 4.56 cm/sec. The myocardium was stimulated by inductorium at a given position on the revolving drum so that outflow from but one contraction was collected along the length of the paper strip. However, outflows from 25 contractions were superimposed by repeated revolutions and contractions. The strip was then dried and cut into numbered segments of fixed length, which were placed into planchettes for counting, using the automatic sample changer equipment of Tracerlab, Inc.

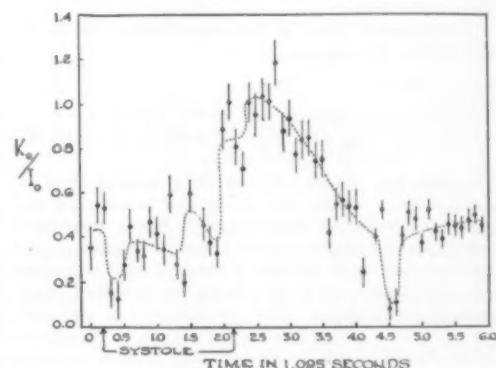


FIG. 1. Effluoradiogram for turtle ventricle pre-equilibrated against  $K^{42}$  *in vitro* and then perfused with  $K^{42}$ -free Ringer's containing  $I^{131}$  as NaI.

As mentioned above, the volume of effluent perfusate caught on each segment is computed from  $I^{131}$  mixed into the turtle Ringer ahead of time. The  $I^{131}$  and  $K^{42}$  counts may be separated partially with a filter, but we usually separate them by counting the two radioactivities together before and after decay of the short-lived  $K^{42}$ . If absolute calibration for volume is required, a known volume of perfusate containing  $I^{131}$  may be measured onto a paper segment. Self-absorption by the paper is minimal for the energetic  $\beta$ -emission of  $K^{42}$ , and a correction factor may be used for the self-absorption of  $I^{131}$   $\beta$ -emission, provided the paper segments are always dried to constant water content.

An effluoradiogram for the turtle ventricle is shown in Fig. 1. The ordinate  $K_0/I_0$  is the ratio of  $K^{42}$  to  $I^{131}$  counts calculated to be present in a paper seg-

ment at zero time with reference to radioactivity decay. This ratio, which is proportional to the  $K^{42}$  concentration, was computed by the expression

$$\frac{K_0}{I_0} = \frac{D \left[ \frac{S_1}{t_1} - \frac{S_2}{t_2} - d \left( \frac{S_3}{t_3} - \frac{S_4}{t_4} \right) \right]}{d \left( \frac{S_2}{t_2} - \frac{S_4}{t_4} \right)} = \frac{D \cdot K_u}{d \cdot I_u}, \quad (1)$$

where  $S_1$  is the number of counts recorded from a paper segment during the first counting time  $t_1$ . It is the sum of the counts contributed by  $K^{42}$ ,  $I^{131}$ , and background.  $S_2$  is the number of counts recorded in time  $t_2$  from the same paper segment 5 days later when effectively all the  $K^{42}$  has decayed. This is the sum of the counts of the partially decayed  $I^{131}$  and background.  $S_3$  and  $S_4$ , counts recorded over time  $t_3$  and  $t_4$ , are backgrounds taken as proper corrections for  $S_1$  and  $S_2$ . The factor  $d$  corrects for the decay of  $I^{131}$  over the 5-day interval, thus adjusting  $S_2$  back to the time of  $S_1$ ;  $D$  corrects for the decay of  $K^{42}$ , thus adjusting the initial  $K^{42}$  count back to zero time.  $K_u$  and  $I_u$  are the counting rates of  $K^{42}$  and  $I^{131}$ , respectively, corrected for everything except their own decay.

The standard error in the determination of  $K_0/I_0$  is given by the expression:

$$\sigma_{K_0/I_0} = K_0/I_0 \sqrt{\frac{S_1/t_1^2 + S_2/t_2^2 + d^2(S_3/t_3^2 + S_4/t_4^2)}{K_u^2} + \frac{S_2/t_2^2 + S_4/t_4^2}{I_u^2}} \quad (2)$$

The plus and minus value of the standard error is marked by a vertical bar above and below each experimental point in Figs. 1 and 2. For a given  $K^{42}$  counting rate and given rates of the two backgrounds, the optimum rate for the  $I^{131}$  count for minimum counting error is given by solving Eq. (3) for  $I_u$  and correcting for decay.

$$I_u^2 d (1/S_1 + 1/S_2) + I_u^2 = \left( \frac{K_u + S_3/t_3}{S_1} + \frac{d S_4/t_4}{S_2} \right) - \frac{K_u^2 S_2/t_2}{d S_2} = 0. \quad (3)$$

The derivation of Eq. (3) assumed either that the

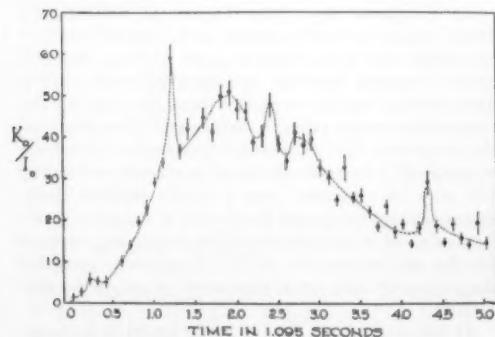


FIG. 2. Effluoradiogram for carotid arterial blood after injection of  $K^{42}$  into the femoral vein of a rat.

background  $S_4$  is counted long enough that  $S_4 = S_2$  or that background is sufficiently smaller than the  $I^{131}$  counting rate that the square of the background is negligibly small with respect to  $I_u^2$ .

Minor fluctuations in the dotted line in Fig. 1 are not to be taken as significant. Their existence, if real, suggests a difference in circulation times among various regions of the vascular bed. The time between the onset of systole and the successive rises in  $K^{42}$  concentration may be attributed to the travel time of the fluid between the capillaries and the collection site. Changes in the amounts of  $K^{42}$  counted are the source of the fluctuations, since the  $I^{131}$  count for volume remains fairly constant. There is, however, an over-all increase in flow at the end of systole which is offset by an even larger increase in the amount of the released  $K^{42}$  in the vascular fluid. Refinements in technique that will permit corrections for travel time and for individual variations in the geometry of the vascular bed are now being developed. These refinements and the physiological interpretations that they permit will be reported at a later date.

We further visualize an effluorochromatogram. The outflow might be caught along one edge of a filter paper rectangle. The effluent chemicals from the muscle, now dispersed horizontally in time along the length of the paper, might then be induced to migrate vertically on the paper by the method of chromatography. Chemicals all emitted from the tissue at a given time could be related as to quantity. If two chemicals were adsorbed together on the chromatogram, it would be suspected that chemical association or complexing was present as they emerged from the tissue. A more onerous task would be to attempt two-dimensional chromatography—horizontal displacement by chromatography of chemicals that had previously migrated vertically above each time segment.

Ginsburg and Wilde (1) have used the method to construct the mixing curve for  $K^{42}$  in the circulation after injection into the femoral vein of rats. This is the "indicator dilution curve" used to measure cardiac output by the single injection method (2). Arterial blood was led onto the filter paper strip from polyethylene tubing cannulated into the carotid artery. The volume of blood collected onto each paper segment was estimated from radioactive iodinated plasma albumin injected and equilibrated in the rat circulation ahead of time. By this method points were recorded every 0.1095 sec (Fig. 2), whereas in earlier work (2) 2-sec intervals were required. The irregularity to the right of the initial peak might be due to the continuing injection, which began at -4.7 and ended at +0.3 sec. If the injection can be accomplished in a shorter time, fluctuations indicative of possible arterial-venous shunts in the lungs or of re-circulation through the coronary system of the heart may be found.

#### References

1. GINSBURG, J., and WILDE, W. S. Unpublished observations.
2. SHEPPARD, C. W., et al. In preparation.

Manuscript received March 17, 1952.

## Effect of Peripheral Shielding on Lymphoid Tissue Response to Irradiation in C 57 Black Mice<sup>1</sup>

Henry S. Kaplan and Mary B. Brown

Department of Radiology,  
Stanford University School of Medicine,  
San Francisco, California

Lymphoid tumors originating in the thymus are consistently induced with high yield by periodic systemic irradiation of strain C 57 black mice (1). Their development is largely inhibited by placing a lead shield over the thigh or other peripheral regions during treatment, despite the fact that the thymus receives the same x-ray dose (2). It has now been found that initial thymus injury is not affected, but that thymic recovery is significantly accelerated by thigh shielding. Lymph node recovery is also accelerated, though to a lesser degree.

Littermate mice of both sexes, aged  $33 \pm 3$  days at the start of treatment, were assigned to one of two groups designated for sacrifice at serial time intervals. Four exposures of 168 r each were delivered at 8-day intervals on experimental days 1, 9, 17, and 25. Physical factors were 120 kvp, 9 ma, 0.25 mm Cu + 1.0 mm Al added filter, 30 cm mouse-target distance, 32 r/min. This dose and rhythm of treatment regularly yield a lymphoid tumor incidence of 80–95% (3). In one group a lead shield 3 mm thick and 1 cm wide was placed across the right thigh during each exposure; the other irradiated group was unshielded. A third group of untreated controls was established at some of the time intervals studied. There were 6–8 mice/group at each time interval. Determinations at 29 and 40 days were rechecked with additional littermates assigned to shielded and unshielded groups. On the designated experimental days the thymus, spleen, and pooled superficial lymph nodes (2 axillary, 2 inguinal) were rapidly excised, dissected free of surrounding fat and connective tissue, and weighed on a torsion balance. Portions of each tissue were taken for fixation in Bouin's fluid and subsequent histologic examination; the remaining portions were used for nucleic acid studies to be reported later.

The weights of thymus and pooled lymph nodes are summarized in Figs. 1 and 2. Reduction in weight occurred after each irradiation, with partial recovery between successive exposures. Initial response was almost identical in the shielded and unshielded groups. Within 4 days after the last treatment, however, mean thymic weights were significantly greater ( $P = < .001$ ) in the shielded mice than in their unshielded littermates. Thymic weight recovered rapidly thereafter in the shielded animals, overshooting control levels at 55 days and settling slowly back to normal afterward. Thymic weight in the unshielded animals did not fully recover until 85–100 days. A similar delayed recovery

<sup>1</sup> This investigation was supported by a grant-in-aid from the National Cancer Institute, National Institutes of Health, U. S. Public Health Service.

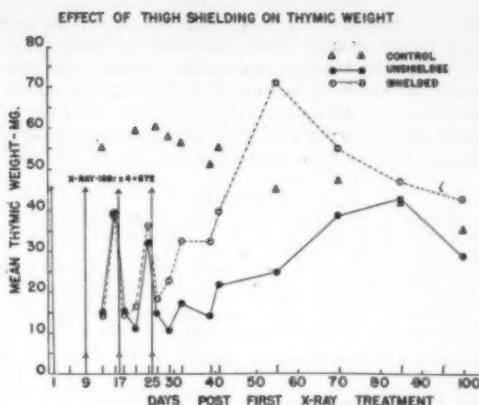


FIG. 1. Effect of peripheral shielding on lymphoid tissue response to irradiation in C 57 black mice.

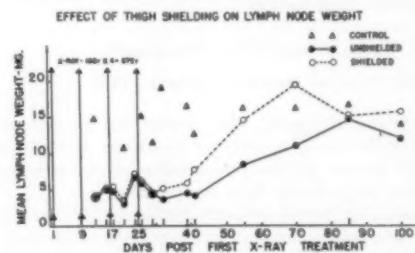


FIG. 2. Effect of thigh shielding on lymph node weight.

occurred in lymph nodes, but acceleration of recovery by shielding was less striking. Recovery of spleen weights occurred promptly in both irradiated groups.

Histologic examination revealed an initial profound reduction in lymphocytes, with "reversal" of relative cellularity of thymic cortex and medulla in both irradiated groups (4). Proliferation of lymphocytes with partial re-establishment of the cortex had occurred by day 29 in the shielded animals, and morphologically normal though small thymus glands were seen by 32 days. Similar stages of histologic repair were delayed by several days in the unshielded animals. Differences in the rapidity of histologic recovery were suggestive in lymph nodes also, but were of lesser degree. Proliferation of erythropoietic and myelopoietic elements in the red splenic pulp was seen in most instances at 29 days and probably accounts for the rapidity with which the spleen regained normal size and weight in both irradiated groups.

It seems reasonable to suppose that the effects of thigh shielding on thymic recovery and on inhibition of thymic lymphomas are related phenomena. On this assumption, it appears that the severity of the initial thymic radiation injury is less significant than the length of time required for recovery as an index of the probability of subsequent lymphoid tumor development. A possible clue to the mechanism by which thigh shielding acts is afforded by the recently re-

ported protective effect of injected bone marrow suspensions against acute radiation mortality (5). Whether bone marrow suspensions release a humoral agent, as has been postulated in the case of spleen shielding (6), or simply provide colonies of undamaged cells for repopulation of irradiated hematopoietic tissues, remains to be established.

#### References

1. KAPLAN, H. S. *J. Natl. Cancer Inst.*, **11**, 83 (1950).
2. KAPLAN, H. S., and BROWN, M. B. *Ibid.*, **12**, 427 (1951).
3. —. *Cancer Research*, **11**, 262 (1951).
4. MURRAY, R. G. In William Bloom (Ed.), *Histopathology of Irradiation from External and Internal Sources*. New York: McGraw-Hill (1948).
5. LORENZ, E., et al. *J. Natl. Cancer Inst.*, **12**, 197 (1951).
6. JACOBSON, L. O., et al. *Science*, **113**, 510 (1951).

Manuscript received March 17, 1952.

### An Investigation of Antimony Oxide as an Opacifier for Porcelain Enamels and Glass<sup>1</sup>

A. E. Pavlish<sup>2</sup> and L. S. O'Bannon<sup>3</sup>

Battelle Memorial Institute, Columbus, Ohio

Experimental work was carried out to determine the feasibility of opacifying porcelain enamels and special glasses by the precipitation of an antimony-bearing phase in the basis composition.

During the period between 1935 and 1940, antimony oxide and sodium antimonate were used extensively in the production of opaque white porcelain enamels. Since 1940, however, zirconium oxide and, even more recently, titanium oxide have practically replaced antimony oxide as the opacifying material in wet-process, sheet-steel enamels, although appreciable quantities of antimony oxide and sodium antimonate still are being used in the dry-process cast-iron enameling industry. The zirconia-bearing and titania-bearing enamels have higher opacity per unit of weight, higher gloss, and, in the case of titania enamels, high resistance to acids. In the case of the conventional antimony-bearing enamels, opacification essentially is accomplished by the physical dispersion of a finely divided antimony compound in the glass. In the case of the titania and zirconia enamels, the mechanism of opacification consists of the precipitation of the opacifying phase during the firing operation. Work was therefore carried out to determine whether glass systems might be developed which would permit the precipitation of an antimony-bearing phase in an enamel-like composition, thereby obtaining higher opacity than is possible with present compositions.

<sup>1</sup> The permission of the Texas Mining and Smelting Division of the National Lead Company to publish the results of this investigation, and the assistance of L. O. Upton, I. Mockrin, and C. R. Austin on various phases of the study, are gratefully acknowledged.

<sup>2</sup> Formerly a member of the staff of Battelle Memorial Institute; now technical director, Kelley Island Lime and Transport Company, Cleveland, Ohio.

<sup>3</sup> Consultant, Ceramic Research, Battelle Memorial Institute, Columbus, Ohio.

It has generally been agreed (1, 2) that, in dealing with recrystallization phenomena, the composition and the time-temperature relationships are important controlling factors in obtaining opacity in, for example, opal glasses. In the production of an opaque glass by recrystallization, another factor—namely, the nature of the crystalline product produced—also is of importance. The size and number of crystallites as well as their composition will influence the opacity of the glass. Blau (1) presented an excellent discussion of the effect of inclusions on the opacity of a glass. The opacifying compound in an antimony-bearing enamel has been described variously as antimony pentoxide (3, 4) or as an antimony, calcium, oxygen, and fluorine compound of high opacity (5, 6). Some confusion also appears to exist as to the exact identity of the compound responsible for the opacity in enamels of the zirconia or titania types (3, 6, 7). Opacifying compounds said to be present in the crystalline phase in enamels and opal glasses are sodium fluoride and calcium fluoride.

Kreidl and Weyl (2) attributed the importance of the fluoride ion to its small atomic radius and, accordingly, to the strong forces exerted on neighboring atoms. The importance of alumina as a constituent in opal glasses (2), in enamels (7, 8), and in matte glazes (9) has been mentioned. Another oxide generally considered to be important in enamels and opal glasses is zinc oxide. This oxide was stated to increase the rate of crystal growth in opal glasses (2), whereas, in zirconia enamels, its effect on opacity apparently was like that of alumina, resulting in a reduction of the solubility of zirconia (8). Other materials that have been held to be important in the development of opacity in antimony-bearing enamels include oxidizing agents such as sodium nitrate (10), potassium nitrate, or zinc nitrate; calcium compounds such as calcium fluoride (5, 11, 12); and sodium silicofluoride (13).

This paper covers the experimental results obtained during an investigation of the effect of various additions on the opacity of a high-antimony basis porcelain enamel-like glass. The composition of the glass and the additions were based on a considerable amount of laboratory work of an exploratory nature which led to these trials.

The analyzed composition of the basis enamel used in this investigation was as follows:

Oxide	Amount (%)
Na <sub>2</sub> O	20.8
B <sub>2</sub> O <sub>3</sub>	12.5
SiO <sub>2</sub>	46.6
Sb <sub>2</sub> O <sub>5</sub>	19.1
R <sub>2</sub> O <sub>3</sub>	0.2
H <sub>2</sub> O	

Various oxides or combinations of oxides were added to this composition as opacifiers. In tests in which the addition amounted to 20%, the oxides were added to the raw batch. When the additions amounted to less than 20%, however, they were added to a pre-

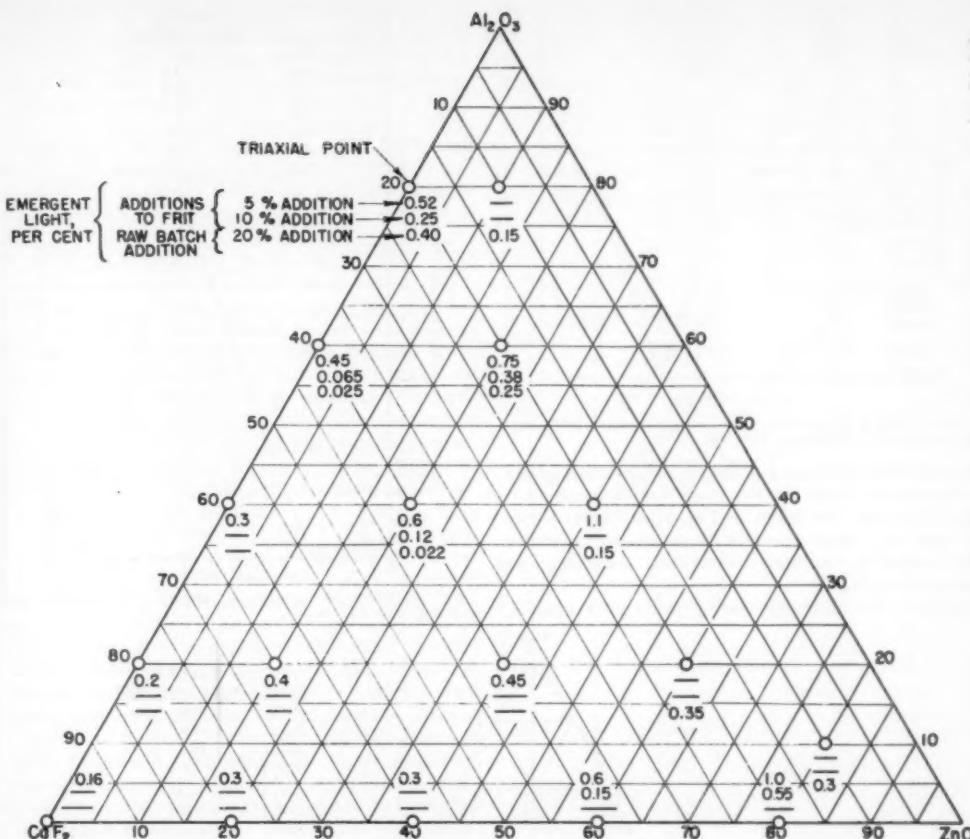


FIG. 1. Translucency of enamel containing antimony oxide plus additions in the system  $\text{Al}_2\text{O}_3-\text{CaF}_2-\text{ZnO}$ .

viously fritted batch of the basis composition milled to minus 35-mesh size.

The melted or unmelted basis enamel and the desired additives were mixed thoroughly in batches of 150-g size and charged into fire-clay crucibles. The crucibles and their contents were heated in a gas-fired furnace to 1500° F in 2 hr, to 2200° F in another 2 hr, and then held for 1 hr at 2200° F. The resultant melts were pressed into blocks, about  $1 \frac{1}{16}'' \times \frac{7}{8}'' \times \frac{1}{2}''$ , for testing. These blocks were placed in an oven at 500° F, held at this temperature for 1 hr, and then cooled in place to room temperature. Reheating tests were made in an electric furnace for various times and temperatures.

The specimens were evaluated visually, and the opacity was determined by using the translucency meter developed by Haldy, Wright, and Todd (14). For the translucency measurements, the specimens were ground, by using a typical horizontal lapping machine, to a thickness of 5 mm,  $\pm 0.1$  mm, to produce two plane parallel surfaces. The surfaces were finished by using No. 22 Carborundum as the abrasive.

Reflectance measurements on these compositions applied as enamels to ground-coated steel were made in the conventional manner of the industry by using a Hunter Multi-Purpose Reflectometer.

Additions of  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{ZnO}$ . Selected mixtures in the system  $\text{Al}_2\text{O}_3-\text{CaF}_2-\text{ZnO}$  were added in amounts of 5, 10, or 20% to the basis composition containing 19.1% of antimony oxide. The composi-

TABLE I  
COMPOSITIONS USED IN STUDY OF EFFECT OF  
SMELTING CONDITIONS ON OPACITY

Enamel No.	Composition (% by wt*)				
	$\text{SiO}_2$	$\text{B}_2\text{O}_3$	$\text{Na}_2\text{O}$	$\text{Al}_2\text{O}_3$	$\text{CaF}_2$
1	45.0	12.0	23.0	12.0	8.0
2	45.0	12.0	23.0	12.0	4.0
3	45.0	12.0	23.0	8.0	8.0
4	45.0	12.0	23.0	8.0	4.0
5	45.0	12.0	23.0	4.0	4.0

\* Twenty per cent of  $\text{Sb}_2\text{O}_3$  added to composition based on total batch.

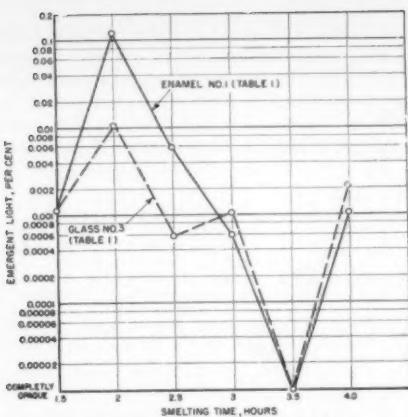


FIG. 2. Effect of smelting time on opacity of an antimony-bearing enamel smelted at 2200° F.

tions of these mixtures and the results of translucency measurements made on the more opaque specimens, after pressing, are shown in Fig. 1. A similar series of tests was made in which these selected mixtures were added to the basis composition containing no antimony oxide.

Most of the antimony-bearing melts were opaque.

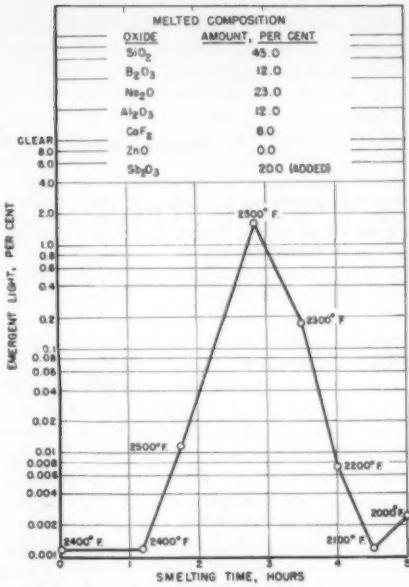


FIG. 3. Effect of variation of smelting temperature and smelting time on opacity.

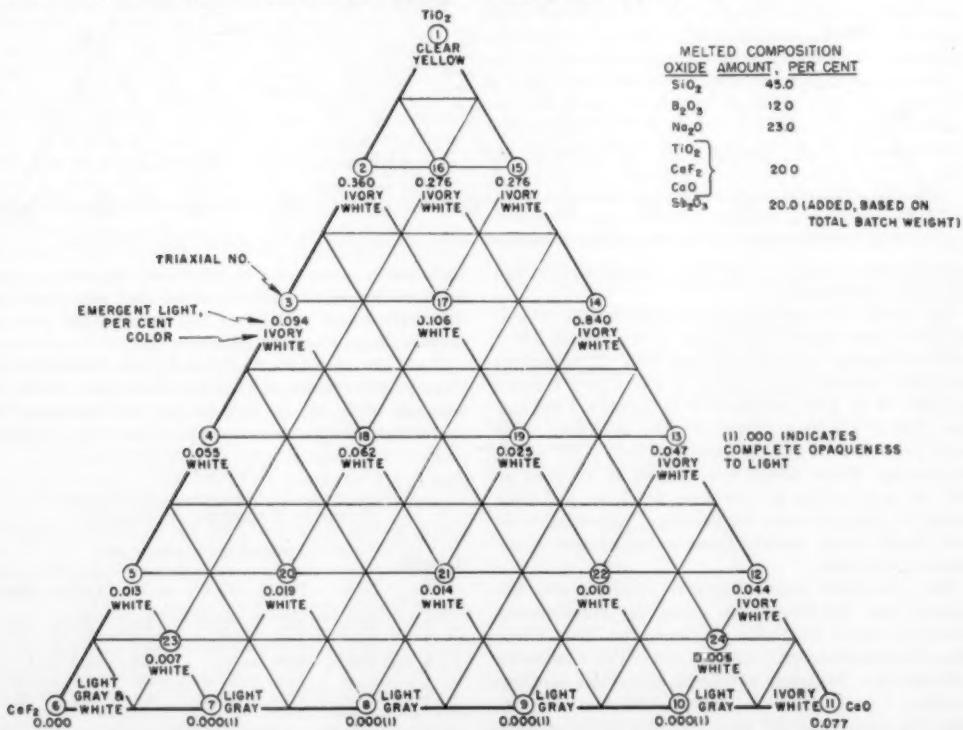


FIG. 4. Effect of additions of titanium oxide, calcium fluoride, and calcium oxide on opacity.

This opacity was due both to the antimony oxide content and to the addition mixtures; enamels containing no antimony, but containing the various additions, were clear.  $\text{CaF}_2$  was the most effective addition in producing opacity; the samples containing no  $\text{CaF}_2$ , either were clear or were partly translucent. High amounts of  $\text{CaF}_2$ , in combination with  $\text{Al}_2\text{O}_3$  and  $\text{ZnO}$ , resulted in a gray color, which yellowed appreciably on reheating. Whiteness and opacity were obtained, however, if  $\text{CaF}_2$  alone, or only small amounts of  $\text{Al}_2\text{O}_3$  or  $\text{ZnO}$ , were added with the  $\text{CaF}_2$ . In these cases, reheating caused no change in the color, but decreased the surface gloss.

The sensitivity of the basis enamel in the development of opacity, when smelted under various conditions, was influenced by the specific additions. Five typical compositions employed in this study are shown in Table 1. The antimony oxide addition was made to the raw batch, and the mixtures were smelted in clay crucibles as before. Two of the compositions exhibited marked variation in opacity when smelted at  $2200^\circ \text{ F}$  for various times; these results are shown graphically in Fig. 2. When these batches were smelted to the clear state at  $2500^\circ \text{ F}$  and then cooled to temperatures ranging from  $2000^\circ$  to  $2300^\circ \text{ F}$  before removal from the furnace, an opacifying phase was precipitated. Data obtained on one of these melts are given in Fig. 3. The other three compositions showed no variation in opacity when smelted at  $2200^\circ \text{ F}$  for variable times, and no opacifying phase was obtained when these compositions were melted to clear glasses and cooled prior to removal from the furnace.

**Additions of  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{CaO}$ .** Additions of  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{CaO}$  were made to the antimony-bearing compositions described previously. These additions were the same as shown on the triaxial diagram in Fig. 1, but the  $\text{ZnO}$  was replaced by  $\text{CaO}$ .

In general, the antimony-bearing specimens containing  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{CaO}$  were opaque. The color varied from pale-green through grayish-white and ivory-gray to gray. High alumina additions usually resulted in homogeneous mixtures of a pale-green, clear, or translucent glass and a white opaque glass. Large additions of  $\text{CaF}_2$  resulted in characteristic gray colors, and  $\text{CaO}$  produced dense, ivory-white opacity. Melts containing various proportions of  $\text{CaF}_2$ ,  $\text{CaO}$ , and  $\text{Al}_2\text{O}_3$  tended to be gray. Reheating caused no apparent change in opacity or color, but resulted in some surface devitrification. Calcium oxide was not as effective as calcium fluoride in producing opacity when added alone.

**Additions of  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{TiO}_2$ .** Additions of  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{TiO}_2$  also were made to the antimony-bearing compositions in the same proportions shown in the triaxial diagram of Fig. 1, but with the  $\text{ZnO}$  replaced by  $\text{TiO}_2$ . In general, the antimony-bearing enamels containing additions of  $\text{Al}_2\text{O}_3$ ,  $\text{CaF}_2$ , and  $\text{TiO}_2$  were opaque and yellowish in color.

**Additions of  $\text{CaO}$ ,  $\text{CaF}_2$ , and  $\text{TiO}_2$ .** Mixtures of  $\text{CaO}$ ,  $\text{CaF}_2$ , and  $\text{TiO}_2$  were added to the antimony-bearing basis enamel in the proportions indicated in

the triaxial diagram of Fig. 1, but with  $\text{Al}_2\text{O}_3$  replaced by  $\text{TiO}_2$  and  $\text{ZnO}$  replaced by  $\text{CaO}$ . The effects of the additions on translucency and color are shown in Fig. 4.

A relatively large number of white, opaque melts were obtained with specific additions of  $\text{TiO}_2$ ,  $\text{CaO}$ , and  $\text{CaF}_2$ . In general, enamels which contained between 4 and 8% of  $\text{TiO}_2$ , between 4 and 16% of  $\text{CaF}_2$ , and between 2 and 16% of  $\text{CaO}$  were the whitest and most opaque. Compositions containing larger amounts

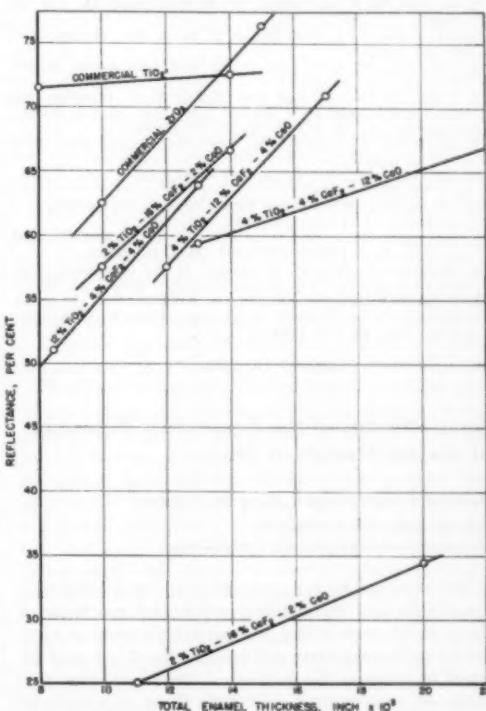


FIG. 5. Reflectance of experimental enamel compositions.

of  $\text{TiO}_2$  were yellow and not so opaque; those containing larger amounts of  $\text{CaO}$  were ivory-white in color and were highly opaque; and those containing greater amounts of  $\text{CaF}_2$ , although extremely opaque, were gray in color.

Five of the most opaque of these compositions were smelted on a larger scale for application to steel in the usual commercial manner; in this work,  $2400\text{-g}$  batches were employed. Colorless melts were obtained in these tests when a faster melting schedule was used than in the experimental tests, but good opacity was developed when the experimental melting schedule was employed. The melts were fritted, milled, and sprayed on ground-coated steel panels in the customary manner. Magnesium carbonate and clay were employed as the mill additions, but no added opacifier was used. The reflectances of the fired coatings were determined and

compared with standard commercial enamels. The results are shown in Fig. 5.

Reflectances between 60 and 70% were obtained with three of the experimental compositions applied to thicknesses of 0.012"-0.014". Commercial enamels opacified with zirconia or titania, however, were more opaque at lower weights of application.

#### References

- BLAU, H. H. *Ind. Eng. Chem.*, **25**, 848 (1933).
- KREIDL, N. J., and WEYL, W. A. *Glass Ind.*, **21**, (2), 57 (1940).
- ANDREWS, A. I., and BREAN, J. G. *J. Am. Ceram. Soc.*, **16**, 325 (1933).
- ANDREWS, A. I., CLARK, G. L., and ALEXANDER, H. W. *Ibid.*, **14**, 634 (1931).
- HARSHAW, W. J., and STILLWELL, A. G. Opacifier for Vitreous Enamels. U. S. Patent 2,200,170 (May 7, 1940).
- KING, B. W. *Jr. Finish.*, **2**, (9), 18 (1945).
- ANDREWS, A. I. *Enamels*. Champaign, Ill.: Twin City Pub., 50 (1935).
- KINZIE, C. J., and COMMONS, C. H., Jr. *J. Am. Ceram. Soc.*, **17**, 283 (1934).
- BINNS, C. F. *Trans. Am. Ceram. Soc.*, **5**, 50 (1903).
- ANDREWS, A. I. *Op. cit.*, 181, 191, 195.
- HARSHAW, W. J., and STILLWELL, W. A. Vitreous Enamel Opacifier. U. S. Patent 2,033,707 (Mar. 10, 1936).
- HERBERT, C. J., and BATEMAN, L. A. Manufacture of Opaquing Agents. U. S. Patent 2,306,354 (Sept. 16, 1940).
- LANG, H. *Glaschütte*, **64**, (8), 121 (1934).
- HALDY, N. L., WRIGHT, J. H., and TODD, F. C. *J. Am. Ceram. Soc.*, **30**, 153 (1947).

Manuscript received March 10, 1952.

### Some Patterns of the Respiratory Pigments of Ascites Tumors of Mice

Britton Chance and LaRoy N. Castor<sup>1</sup>

*Johnson Research Foundation,  
University of Pennsylvania, Philadelphia*

Inasmuch as we are now able to record accurately the visible and ultraviolet spectra and reactions of the pyridine nucleotides and the cytochromes of various tissue homogenates and intact cells (1), it is of interest to compare the pattern of the respiratory pigments of such normal cells with those of neoplastic cells. The ascites tumor, as described recently by Klein (2), is the most suitable type of material for our studies since viable and transmissible tumor cell suspensions are obtained in adequate quantities from a single mouse, and the intact cells are studied directly by our methods, without the need for homogenization, as would be necessary with solid tumors. A further advantage of these cells is that they are maximally dedifferentiated.<sup>2</sup>

The mice<sup>3</sup> were sacrificed on the sixth to fifteenth day after inoculation, the tumor cells were freed from erythrocytes by osmotic shock (differential lysis), and the hemoglobin was largely removed by subsequent washing at 0°. The tumor cell counts then averaged about  $5 \times 10^6/\text{mm}^3$  for the Ehrlich and Krebs 2 sus-

<sup>1</sup> Lalor Foundation predoctoral fellow.

<sup>2</sup> Dale Coman kindly suggested the use of ascites tumor.

<sup>3</sup> T. S. Coman, of the Cancer Research Institute, Fox Chase, Pa., very kindly supplied us with mice inoculated with Ehrlich, Krebs 2, and dba thymoma ascites.

pensions, and the  $Q_{O_2}$  was about 3 at 25° with glucose as a substrate. Successful results were obtained with three tumor cell types: Ehrlich, Krebs 2, and dba thymoma ascites (3).

The changes in optical density measured here are those that occur upon the exhaustion of the oxygen dissolved in the cell suspension. The normal respiration of our cell suspensions causes anaerobiosis to occur in several minutes. At that time those pigments oxidized by respiratory activity become reduced. A typical experiment is represented by Fig. 1, where the

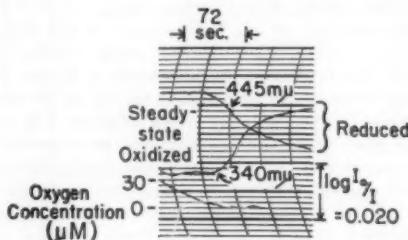


FIG. 1. An illustration of the spectrophotometric measurement of optical density changes in a respiring ascites tumor cell suspension that are coincident with the termination of the oxidase activity. An upward deflection of the traces at 340  $\mu\text{m}$  represents an increase of optical density, whereas a downward deflection at 445  $\mu\text{m}$  represents an increase of optical density; dba thymoma, cell count,  $1.7 \times 10^6/\text{mm}^3$ . (Expt 921-12.)

respiration is automatically recorded from polarographic analyses with a platinum electrode. There is no deflection of the spectrophotometric trace in the steady-state oxidized system, but, upon exhaustion of the oxygen, there is a reduction of cytochrome  $a_3$  (a downward deflection of the trace at 445  $\mu\text{m}$  corresponds to an increase of optical density) and of pyridine nucleotide (an upward deflection of the trace at 340  $\mu\text{m}$  corresponds to an increase of optical density). The complete spectrum representing the difference between the reduced and the steady-state oxidized condition of the respiratory pigments is obtained by repeating the experiment of Fig. 1 at various wavelengths or by using a continuous recorder (4, 5).

Our results for Krebs 2 ascites tumor cells are given in Fig. 2. These spectra are dominated by cytochrome  $c$ ; the strong visible bands at 549.5, 520, and the Soret

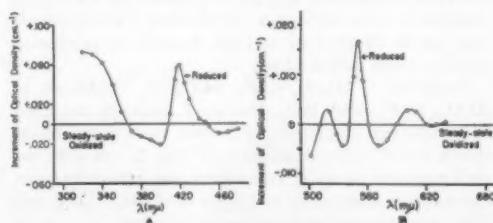


FIG. 2. The spectra representing the difference between the reduced and steady-state oxidized respiratory pigments of Krebs 2 ascites tumor; cell count,  $5.8 \times 10^6/\text{mm}^3$ . (Expt 921-4.)

TABLE I  
COMPARISON OF THE PATTERN OF RESPIRATORY PIGMENTS OF TUMOR AND OTHER CELLS

Material	Expt No.	$K_4 = \mu\text{M}\text{O}_2/\text{sec}$ $\Delta D_{445-480}$ (25°)	Relative optical density changes*				DPNH
			a	b	c	$a_3$	
Keilin and Hartree heart muscle preparation (6)	880b	49	1	0.6	0.8	9	—
Rabbit heart sarcosomes†	923e	14	1	0.8	0.9	11	—
Fly muscle sarcosomes‡	910e	12	1	0.6	1.5	9	—
Bakers' yeast cells	876a	160	1	1.7	2.7	11	60
	918f						
Ehrlich ascites	921-8	37	1	< 0.5	4	12	—
Krebs 2 ascites	921-4	40	1	< 0.5	4	6	13
dba thymoma§	921-12	32	1	0.4	2	6	11

\* In this table we have evaluated the optical density changes from the peak to the trough of the absorption band—cytochrome *a*:  $\Delta D_{480}-\Delta D_{500}$ ; cytochrome *b*:  $\Delta D_{520}-\Delta D_{550}$ ; cytochrome *c*:  $\Delta D_{550}-\Delta D_{580}$ ; cytochrome *a<sub>3</sub>*:  $\Delta D_{445}-\Delta D_{480}$ .

† Prepared according to unpublished data of E. C. Slater.

‡ Prepared from blowflies kindly furnished by M. I. Watanabe, Quartermaster Corps, Philadelphia.

§ The tumor cells were suspended in a medium consisting of 0.85% sodium chloride, 0.025% potassium chloride, 0.030% calcium chloride, to which 0.1% glucose was added.

|| The value of  $\Delta D_{445}-\Delta D_{480}$  was corrected for cytochrome-c absorption.

band at 419 m $\mu$  identify this pigment with certainty and indicate it to be present in a relatively large concentration. Cytochrome *a* is observed at 605 m $\mu$ , and cytochrome *a<sub>3</sub>* as the small shoulder on the Soret band at 445 m $\mu$ . Reduced pyridine nucleotide absorbs below 340 m $\mu$ .

Since these ascites cells do not retain the characteristics of the tissue of origin (2), we have chosen to compare their respiratory pigments with those of muscle and yeast cells, of high respiratory activity, as given elsewhere (1). Such a comparison is aided by the data of Table I, in which the relative intensities of the absorption bands of the 4 cytochromes and pyridine nucleotides of 4 types of normal cells and 3 types of ascites tumors are compared. In addition the quantity,  $K_4 = \mu\text{M}\text{O}_2/\text{sec}/\Delta D_{445-480}$ , is included. This quantity is our criterion of the intensity at which cytochrome oxidase is operating and is related to the actual turnover number of the enzyme. (Since the respiration rate in these tumor cells is considerable, the respiratory pigments may already be partly reduced in the steady-state oxidized condition [1]. But, in view of the values of  $K_4$  and our studies of heart muscle preparations, only about 10% of cytochromes *a* and *a<sub>3</sub>*, and 30% of cytochrome *c*, would be so reduced.)

Turning our attention first to the consistencies of the patterns, we find that the quotient of the absorption change at 445 m $\mu$ , due mainly to cytochrome *a<sub>3</sub>*, and of the absorption change at 605 m $\mu$ , due mainly to cytochrome *a*, varies from 6 to 12 and is fairly close to the average value of 10 for normal cells. Studies of the effect of carbon monoxide upon the absorption bands at 445 and 605 m $\mu$  in the tumor cells verify the approximately normal relative values of cytochromes *a<sub>3</sub>* and *a*.

A second consistency is seen in the values of  $K_4$  which indicate that the turnover number of cytochrome *a<sub>3</sub>* is a rather usual value; the amount of

cytochrome oxidase present is working at a moderate rate, slow compared to yeast, but fast compared to mitochondrial preparations from heart muscle.

Reduced pyridine nucleotide is readily detected in these cells in a reasonable amount.

There are, however, some significant inconsistencies in these patterns. Cytochrome *b* is a pigment whose absorption band is conspicuously absent from the spectra of Fig. 2; no shoulder appears on the 550 m $\mu$  absorption band of cytochrome *c*, nor is there any peak at 430 m $\mu$ . A more sensitive test for cytochrome *b* is to add antimycin *a* (7) to the aerated suspension and thereby to uncouple cytochrome *b* from the other cytochromes and permit its aerobic reduction. Such a test reveals a barely detectable absorption band in Ehrlich and Krebs 2 cells and points to their large relative deficiency of cytochrome *b*. In dba thymoma, we were able positively to identify cytochrome *b*.

Cytochrome *c* shows the most marked inconsistency, and the amount of this pigment is abnormally great in all samples tested. The relative content of cytochrome *c* found in the Ehrlich and Krebs 2 tumor cells actually exceeds that of the very highly respiring yeast cell.

In summary, we can state that the respiratory activity of ascites tumor cells, mediated by cytochromes *a<sub>3</sub>* and *a*, closely follows the pattern of normal muscle and yeast cells. Cytochrome *c* is present in an unusually large amount relative to cytochrome *a* and *a<sub>3</sub>*, and cytochrome *b* is difficult to detect at all—the cytochrome *c* to cytochrome *b* ratio in these ascites tumors is over fourfold greater than that of mammalian heart muscle.

In comparing our results on the relative content of cytochrome *c* and cytochrome *a<sub>3</sub>* of these tumors with those obtained by previous workers on solid tumors, it is of interest to note that they concluded that the disparity of these two components is of just the opposite sense, cytochrome *c* being relatively de-

cient with respect to cytochrome oxidase (8). We believe that our direct spectroscopic study of the pigments of the intact, freely suspended, respiring tumor cells is somewhat more decisive than the various indirect assay methods that have led to the earlier conclusions.

#### References

1. CHANCE, B. *Nature*, **169**, 215 (1952).
2. KLEIN, G. *Cancer*, **3**, 1052 (1950).
3. HAUSCHKA, T. S. (To be published.)
4. CHANCE, B. *Rev. Sci. Instruments*, **22**, 619 (1951).
5. YANG, C. C. Paper presented at mtg. Inst. Radio Engrs. (Mar. 2, 1952).
6. KEILIN, D., and HARTREE, E. F. *Biochem. J.*, **41**, 500 (1947).
7. AHMAD, K., SCHNEIDER, H. G., and STRONG, F. M. *Arch. Biochem.*, **28**, 281 (1950).
8. GREENSTEIN, J. P. *Biochemistry of Cancer*. New York: Academic Press, 269 (1947).

Manuscript received February 25, 1952.

## The State of Catalase in the Respiring Bacterial Cell<sup>1</sup>

Britton Chance

*Johnson Research Foundation,  
University of Pennsylvania, Philadelphia*

The physiological role of catalase has remained obscure because the two substances necessary for catalase action (a substrate such as peroxide and a hydrogen donor such as an alcohol, or nitrous or formic acid [1]) have not been proved to be present simultaneously in adequate concentrations in the respiring cell (1). In this paper we show the existence of both types of substances and, furthermore, show how the steady-state peroxide concentration can be regulated by the addition of suitable hydrogen donors, a point of some importance in the control of peroxide produced within the cell. The paper also provides the first demonstration of an enzyme-substrate compound in action *in vivo*.

By means of sensitive spectrophotometric methods (2) we can now study the spectra and kinetics of catalase and cytochrome in respiring suspensions of *Micrococcus lysodeikticus* (3).<sup>2</sup> We find catalase in the form of its primary hydrogen peroxide complex (complex I) (4) in the aerobic bacterial cells. The complex is identified by its specificity for donors such as nitrous and formic acid and by its absorption spectrum, as previously determined by *in vitro* studies of the pure crystalline enzyme (5).

When catalase is continuously supplied with hydrogen peroxide from an oxidase system, we have shown *in vitro* that the steady-state concentration of complex I may be considerably reduced by the addition of a donor (6). The same experiment is here re-

<sup>1</sup>This research was supported in part by funds from the Division of Research Grants and Fellowships, USPHS, and from the Office of Naval Research.

<sup>2</sup>The fact that this bacterium has an unusually large catalase content means that a higher level of free peroxide concentration is required to reach the saturation value of complex I.

peated with intact respiring cells, as shown in Fig. 1, A. The recording spectrophotometer is responsive

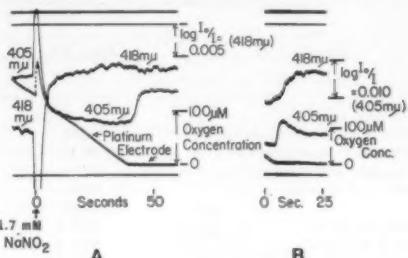


FIG. 1. A: Spectrophotometric recording of the addition of nitrite to a respiring suspension of *M. lysodeikticus*. The respiration of the bacteria is indicated by the linear decrease of the polarographic trace. The double beam spectrophotometer was set at 405 mμ and 418 mμ and records an increase of optical density as an upward deflection of the 418 mμ trace and a downward deflection of the 405 mμ trace (to avoid trace superposition). Cells suspended in a phosphate medium of pH = 7.0 with 2.7 mM glucose present; 1.7 mM nitrite added. (Expt 922b.) B: A similar record, but nitrite is omitted. (Expt 922a.)

to a change in the concentration of complex I at both 405 mμ (the peak of the complex I band) and 418 mμ (a wavelength at which the cytochromes of the bacteria do not interfere with the measurement of complex I). Both traces show an increase of optical density upon addition of 1.7 mM nitrite (or in other tests, a larger formate concentration), as would be expected when the steady-state concentration of complex I is reduced. (The absorption band of free catalase is higher than that of complex I [5, Fig. 3].) Upon exhaustion of the oxygen, the cytochromes are reduced, as shown by the decrease of optical density at 405 mμ. In the absence of added donor, complex I is present aerobically, and rapidly decomposes upon exhaustion of the oxygen, as clearly shown by the trace at 418 mμ in Fig. 1, B. These two experiments suggest that complex I is present in respiring cells and that adequate endogenous donor is present to cause its rapid decomposition when the cells become anaerobic.

The spectrum of the change in absorption caused by the addition of a catalase donor to aerobic cells is obtained by repeating the experiment of Fig. 1, A at various wavelengths or by using a sensitive recorder (7) as shown by Fig. 2, Curve A. This difference spectrum is identical to our *in vitro* result for complex I (5). For comparison, the cytochrome absorption is recorded in Curve B. Further proof of our conclusion is afforded by adding methyl hydrogen peroxide to the aerated cells, which greatly decreases the absorption (Fig. 2, C) as a result of further binding of catalase hematin as complex I of methyl hydrogen peroxide, in agreement with our *in vitro* studies (5, Fig. 4). A comparison of Curves A and C shows that about 1.6 molecules of hydrogen peroxide are bound to the 4 hematin of bacterial catalase *in vivo*, in accord with the *in vitro* calcula-

tion (5). This result strongly supports our conclusion that hydrogen peroxide is bound to catalase in the respiring cell.

Many other data support our identification of complex I; these include the gradation of the activity toward nitrite, formate, and ethanol, and the formation of the distinctive azide-catalase-peroxide complex.

By adding various formate concentrations to the respiring bacteria we find that roughly 2 mM formate halves the steady-state concentration of complex I. For this case, we have already shown that the steady-state hydrogen peroxide concentration can be computed (6). Our result for respiring *M. lysodeikticus* is about  $10^{-8} M H_2O_2$ .

At such low peroxide concentrations, the "catalatic" decomposition of hydrogen peroxide into water and oxygen proceeds relatively slowly<sup>3</sup> because of the

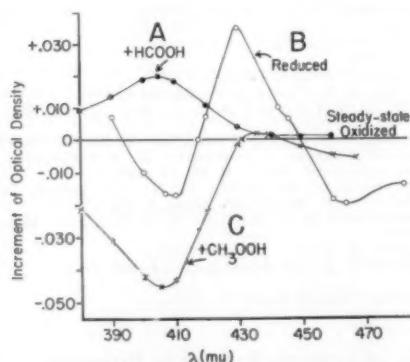


FIG. 2. Spectra representing changes in the optical density of a respiring suspension of *M. lysodeikticus*: (A) when 1.7 mM formate is added, (B) when the cytochromes are reduced by anerobiosis, (C) when 67 μM methyl hydrogen peroxide is added. (Expt 924.)

peculiar mechanism of catalase action (6, 8). The addition of a suitable donor such as formate or nitrite causes catalase to act "peroxidatively" and thereby reduces the steady-state peroxide concentration. Thus the endogenous peroxide concentration may be regulated by the exogenous donor concentration.

On the basis of our *in vitro* studies of catalase action, Cole, Bond, and Fishler (9) have postulated that nitrite protects mice from x-radiation by reaction with complex I. And Hollaender has also shown the protection of bacterial cells from x-rays by formate, ethanol, and glycols (10). Our data on the *in vivo* interactions of catalase, hydrogen peroxide, and donor substances now give direct evidence in favor of the mechanism by which catalase may participate in the control of hydrogen peroxide and perhaps in protection from ionizing radiations.

<sup>3</sup> We estimate that about four times as much peroxide is decomposed "catalatically" as "peroxidatively" in the respiring cell (6).

## References

1. CHANCE, B. In F. F. Nord (Ed.), *Advances in Enzymol.*, **12**, 153 (1951).
2. ———. *Rev. Sci. Instruments*, **23**, 619 (1951).
3. ———. *Nature*, **169**, 215 (1952).
4. ———. *Acta Chem. Scand.*, **1**, 236 (1947).
5. CHANCE, B., and HERBERT, D. *Biochem. J.*, **46**, 402 (1950).
6. CHANCE, B. *Ibid.*, 387.
7. YANG, C. C. Paper presented at mtg. Inst. Radio Engrs. (1952).
8. CHANCE, B., GREENSTEIN, D. S., and ROUGHTON, F. J. W. *Arch. Biochem. Biophys.* (in press).
9. COLE, L. J., BOND, V. P., and FISHLER, M. C. *Science*, **115**, 644 (1952).
10. HOLLAENDER, A., STAPLETON, G. E., and BURNETT, W. T., Jr. *Abstracts, Mtg. Am. Chem. Soc.*, 14C (Sept. 3-7, 1951).

Manuscript received February 25, 1952.

## Schwarzchild-Villiger Effect in Microspectrophotometry

Leonard Ornstein and Arthur W. Pollister

Department of Zoology,  
Columbia University, New York

Since at least 1903 (1), the experienced microscopist has been aware of the cause of and cures for lenticular glare (flare). This fault of refracting optical systems has been one of the main enemies of the cytologist in his constant battle for microscopic contrast and resolution. Cellular microspectrophotometry has been a natural outgrowth of cytology (2, 3). When the cytologist turns to this new technique in cellular studies, he naturally brings with him his thorough background in microscopical practice, which includes the routine rules for the control of lenticular glare.

These are (4-7): (a) the smaller the cone of illuminating light (i.e., the smaller the condenser aperture), the less the glare; (b) the smaller the area of the object illuminated, the less the glare.

The effect of glare in microdensitometry (in terms of [b]) came to the attention of the astrophysicists Schwarzchild and Villiger (8) in a study on the intensity distributions in the image of the solar disk. Naora has based a recent critique (9) of present methods of cellular microspectrophotometry on his familiarity with the Schwarzchild-Villiger effect. Although giving considerable attention to the dependence of glare on the magnitude of the area illuminated, he has apparently neglected the fact that, as the condenser aperture is reduced, glare is reduced and he thereby overestimates the magnitude of the glare error in the current technique.

Thus far, in most microspectrophotometric studies, small condenser apertures have been used, and for convenience of searching and maintaining adequate alignment the illuminated field has been kept as large as 30 μ in diameter. For example, Swift has explicitly prescribed such conditions for the expressed purpose of reducing glare to a low level (10). With clean optics, and with the refractive index of the specimen matched by the mounting medium (3), the above precautions limit the total measured glare intensity in

the plane of the image from all sources (scattering by lens inclusions, reflections from lens mounts and the inside of the "blackened" microscope tube and stops, lens aberrations, and the multiple reflections between the lens surfaces) to considerably less than 3% of the focused illuminating intensity for most oil immersion systems. For transmittances which fall in the range of those of the quantitative studies already published (viz., 10–15), this error has been negligible beside the other known errors of the method. It cannot have any relation to the validity of the conclusions these authors have drawn from their data.

Naora has used the expression  $\frac{(1-\bar{r})}{1+(m-1)\bar{r}}$  as representative of their total flux, imaging,  $(1-\bar{r})^m$ , plus glare flux through a lens system with  $m$  air-glass interfaces of average reflectance  $\bar{r}$  (9). He has assumed that equal fractions of the total glare flux and imaging flux fall on a given area of the image. (It is important to note that this equation applies only to the ease of  $m$  plane air-glass interfaces, parallel to one another, and for the ease of perfectly normal incidence.)

There are at least two ways in which the above theoretical approximation deviates seriously from the actual situation in microscopical systems. First, very few surfaces in such an optical train are plane elements perpendicular to the optical axis. As a result, all off-axis flux contributes glare diverging from the element at which it "originates" in such a way that the following element usually intercepts less of the solid angle of glare flux than of the focused imaging flux. (As an extreme example, between an objective and an ocular, up to 99% of the glare flux may be lost outside the aperture of the ocular, whereas all the imaging flux is passed if the field of illumination is set equal to the field limited by the ocular field diaphragm in accord with standard microscopical practice. The same holds for glare developed in the ocular with reference to the photocell entrance pupil or a photographic plate [7]). Thus, for small but finite<sup>1</sup> condenser apertures, Naora's calculations represent a large overestimate. As noted above, most microspectrophotometric work is carried on with a small condenser aperture. Second, if a large condenser aperture is chosen for microphotometric studies, as in Naora's case (condenser N.A. equal to objective N.A., in the range of 1.25 [9, 16]), most rays in the system meet the glass-air interfaces at angles very different from the normal. Under these conditions,  $\bar{r}$  is increased (4), and therefore the glare flux is also increased. This, plus the increase in aberration glare as the illuminating aperture is increased, may account for the large amount of glare demonstrated experimentally by Naora's system with even small illuminated fields.

When specimens with high extinctions are studied,

<sup>1</sup> Not so small as to constitute a close approach to a condition where all the flux can be considered to be contained in an infinitesimal on-axis pencil. As this latter condition is approached, glare again increases toward Naora's computed values.

additional precautions will be in order, as Naora has indicated. His approach (that of Schwarzschild and Villiger) of limiting the illumination entirely to the minute area measured is the simplest solution when the convenience of larger illuminated fields of view may be abandoned. Special precautions will be even more important, however, in terms of distributional error and the aberration glare of the lens system. The curve-correction method for distributional error (17) adequately corrects for both glare and inhomogeneous distribution of chromophore.

#### References

- RHEIBERG, J. *English Mech.*, **76**, 463 (1903).
- POLLISTER, A. W., HIMES, M., and ORNSTEIN, L. *Federation Proc.*, **10**, 629 (1951).
- POLLISTER, A. W. *Lab. Investigation*, **1**, 231 (1952).
- BECK, C. J. *Roy. Microscop. Soc.*, 399 (1922).
- . *The Microscope*. London: R. & J. Beck, Ltd. (1938).
- BELLING, J. *The Use of the Microscope*. New York: McGraw-Hill (1930).
- SHILABER, C. P. *Photomicrography*. New York: Wiley (1944).
- SCHWARZSCHILD, K., and VILLIGER, W. *Astrophys. J.*, **23**, 286 (1906).
- NAORA, H. *Science*, **115**, 248 (1952).
- SWIFT, H. H. *Physiol. Zool.*, **23**, 169 (1950).
- RIS, H., and MIRSKY, A. E. *J. Gen. Physiol.*, **33**, 125 (1949).
- ALFERT, M. *J. Cellular Comp. Physiol.*, **38**, 381 (1951).
- LEUCHTENBERGER, C., VENDRELY, R., and VENDRELY, C. *Proc. Natl. Acad. Sci. U. S.*, **37**, 33 (1951).
- POLLISTER, A. W., SWIFT, H. H., and ALFERT, M. *J. Cellular Comp. Physiol.*, **38**, Suppl. 1, 101 (1951).
- HARRINGTON, N. J., and KOZA, R. W. *Biol. Bull.*, **101**, 138 (1951).
- NAORA, H. *Science*, **114**, 279 (1951).
- ORNSTEIN, L. *Lab. Investigation*, **1**, 250 (1952).

Manuscript received March 18, 1952.

#### Study of Irritants Related to Piperine<sup>1</sup>

Torsten Hasselstrom, Harold W. Coles,  
and Norene E. Kennedy

Pioneering Research Laboratories,  
U. S. Army Quartermaster Corps,  
Philadelphia, Pennsylvania

The piperidine nucleus joined by the amide linkage to an unbroken nine-carbon chain produces a peppery pungency taste in compounds of quite different composition, such as pelargonypiperidide (1), 2-phenylthiophene-5-carboxy-piperidide (2), and the piperine of black pepper, *Piper nigrum*. However, the pleasant bite of this spice has been duplicated only by the piperides of  $\beta$ -cinnamyl-acrylic acid, the 5-phenylpentenoic acid, and 5-phenyl-n-valeric acid, of which 5-phenyl-n-valeroyl piperidide has the most pungent taste (3).

It is known that the pharmacologic activity of certain compounds containing piperidine is increased by substitution in the piperidine ring. It was of interest,

<sup>1</sup> Thanks are due to Donald K. Tressler, scientific director, the Quartermaster Food and Container Institute of the Armed Forces, Chicago, Ill., for his interest in this work; to David Peryam, of the same institute, for outlining the taste-testing procedure used; and to the Evans Research and Development Corporation, New York, for carrying out the panel testing.

TABLE I  
CHARACTERISTIC DATA FOR THE 5-PHENYL-*n*-VALEROYLAMIDES

Compound	Formula	Boiling point	Nitrogen (%)	
			Calcd	Found
5-Phenyl- <i>n</i> -valeroyl-2-methylpiperide*	C <sub>17</sub> H <sub>23</sub> ON	163.5°-165.5°/250 μ	5.40	5.72; 5.71
" 3-methylpiperide†	C <sub>17</sub> H <sub>23</sub> ON	145°-146°/350 μ	5.40	5.15; 5.11
" 4-methylpiperide*	C <sub>17</sub> H <sub>23</sub> ON	120°-122°/90 μ	5.40	5.48; 5.48
" pyrrolidide*	C <sub>17</sub> H <sub>23</sub> ON	126°-129°/1-3 μ	6.06	6.44; 6.45
" 3-methylpyrrolidide*	C <sub>18</sub> H <sub>23</sub> ON	97.5°-100.5°/80 μ	5.71	5.32; 5.33
N-5-phenyl- <i>n</i> -valeroylphthalimide†	C <sub>19</sub> H <sub>17</sub> O <sub>2</sub> N	MP, 125°-126°/(Uncorr)	4.56	4.50; 4.51
5-Phenyl- <i>n</i> -valeroyleisobutylamine†	C <sub>19</sub> H <sub>23</sub> ON	153.3°-155.0°/250 μ	6.00	5.58; 5.48

\* Analyses by Jean M. Marino, Pioneering Research Laboratories.

† Analyses by Micro-Tech Laboratories, Skokie, Ill.

therefore, to ascertain whether the taste characteristics of the piperinolike amides could be changed or intensified by the substitution of methyl piperidines (pipercolines) and other amines for the piperidine and yet retain a pleasant peppery bite, without off-flavor.

The procedure recommended by Staudinger and Schneider (3) was followed for the preparation of the acid amides, with the minor modification that the crude amide ether solution was washed with dilute

water infusion, which was prepared by dissolving the synthetic bite principle in ether or ethanol, and adding enough of the solution to ether-extracted black pepper pulp to make a 5% concentration of bite materials. The solvent was then evaporated, and the residue dispersed in water to the extent of 0.1%. These synthetic samples were compared to a 0.1% dispersion of natural malabar pepper in taste-free water. A taste testing panel of eight members carried out the testing (Table 2).

TABLE 2  
PEPPERY-BITE AND TASTE-FLAVOR RATING ON CERTAIN 5-PHENYL-*n*-VALEROYLAMIDES

Compound	Peppery bite strength			Flavor (quality rating)			Flavor (subjective rating)		
	Strong (control)	Moderately weak	Weak or none	Least	Moderate	Most	Slightly pleasant	Neutral or slightly unpleasant	Definitely unpleasant
5-Phenyl- <i>n</i> -valeroyl piperide	x		x				x		
" -2-methylpiperide*	x			x			x		
5-Phenyl- <i>n</i> -valeroyl-3-		*	x	x			x		
" 4-	"	*	x		x		x		
" 4-pyrrolidide*	x			x			x		
" 3-methylpyrrolidide*	x		x	x			x		
N-5-phenyl- <i>n</i> -valeroylphthalimide*			x	x			x		
5-Phenyl- <i>n</i> -valeroyleisobutylamine*			x	x			x		
Pelargonylpiperide	x				x		x		x

\* New.

hydrochloric acid and sodium carbonate to remove excess starting materials before rectification in vacuum. The 5-phenyl-*n*-valeric acid was employed as the acid component, and the amines were prepared by methods previously described in the literature.

N-5-phenyl-*n*-valeroyl phthalimide was prepared by refluxing potassium phthalimide and 5-phenyl-*n*-valeroyl chloride in benzene solution, subsequently recrystallizing the separated organic solid from the same solvent. The properties of the acid amides appear in Table 1.

The taste tests were conducted on a taste-free 0.1%

The result of this work (4) shows that a peppery-bite taste more pleasant than natural piperine or 5-phenyl-*n*-valeroyl piperide was accomplished by the substitution of the pipercolines and methyl pyrrolidines for piperidine.

#### References

1. ASANO, M., and KANEMATSU, T. *J. Pharm. Soc. Japan*, **53**, 375 (1926).
2. STEINKOPF, W., and GORDING, R. *Biochem. Z.*, **292**, 368 (1937).
3. STAUDINGER, H., and SCHNEIDER, H. *Ber.*, **56**, 699 (1923).
4. Paper presented at 75th Anniversary Mtg., Am. Chem. Soc., New York (Sept. 11, 1951).

Manuscript received March 12, 1952.

## Comments and Communications

### Astronomy in the Manner of 1984

War is Peace  
Freedom is Slavery  
Ignorance is Strength  
—George Orwell, 1984.

"In the bourgeois countries we often observe [scientists] helplessly marking time. Let the reader judge for himself how completely benighted are the ideas of many foreign astronomers: [they believe that] all stars are constituted according to a single model, all stars obey a single mass-luminosity relation, all stars originated at the same time, all galaxies were born at the same time—simultaneously with the stars and hence simultaneously with [what they believe to be] the only solar system in existence, and of course also simultaneously with the earth." These "absurd theories" are represented as an attempt of the Western astronomers "to ascribe the origin of the solar system to an excessively rare, unique, occurrence in the universe. This immediately leads them to propound the uniqueness of mankind and, in effect, represents a return to the old geocentric system, to anthropocentrism, and to popery."

Such "reactionary theories" are attributed to Jeans, Jeffreys, Eddington, Milne, Lyttleton, Hoyle, de Sitter, and a host of other Western scientists "among whose ranks there are, however, a few progressive workers who have tried to comprehend the structure of the universe from the position of materialistic science."

Among the "formalistically thinking capitalistic astronomers" mentioned as "not having succeeded in lifting themselves to the level of a comprehensive theoretical understanding of the entire problem" is the theoretical astrophysicist Chandrasekhar "to whom the final goal is the theoretical analysis of some kind of simplified scheme of galactic structure," whereas in reality "the galaxy is complex and in its evolution becomes ever more complex."

The author of these comments is P. P. Parenago, professor of astronomy at Moscow University, and one of the best-known and universally recognized Soviet scientists. It is remarkable that only a few years ago the same Russian author, in a textbook on stellar astronomy, extensively used Chandrasekhar's work—so extensively, in fact, that his introductory acknowledgment in the second edition to the effect that an entire chapter of more than 100 pages "was completely rewritten, principally under the influence of the publications by Chandrasekhar" reads like an understatement.

But, of course, that was in 1944, and the adverse quotations are from a recent book *The World of the*

<sup>1</sup> The Russian word *popovshchina* cannot be exactly translated; the word "clericalism" does not give the correct meaning.

*Stars* (1951). In the intervening years A. A. Zhdanov had laid down the official line of the Soviet Communist Party, which attacked the "idealistic" approach to science of those who "do not understand the dialectic road to knowledge . . . and convert their impotent scientific efforts into a slander of nature." Hence, it becomes now a duty to show that "on the ideological front Soviet astronomy has launched a decisive attack," and that victory "is assured by the paternal interest of the greatest genius of humanity, Comrade Stalin." It seems that the formalistic and capitalistically poisoned results of Chandrasekhar were ideologically purified when clothed in the binding of the *Gostekhizdat*.

Propaganda of this kind has been in progress for so long a time that it may actually be believed by those who repeat it over and over. It may be appropriate to record here a few pertinent observations in the hope that they may come to the attention of our colleagues in the Soviet Union.

The allegations of a medieval mysticism in Western science are, of course, false, as are the specific accusations from Parenago's book. Most Western astronomers are at least as "materialistic" in their scientific reasoning as are their Russian colleagues. Most of them genuinely admire the astronomical work that is done in Russia and are not aware of any basic difference in scientific method between astronomers of Communist and non-Communist countries. The Russian scientific literature abounds in appeals to the scientists of all nations for a peaceful solution of the world's difficulties. Will the Russian astronomers not give thought to the question whether these appeals are consistent with the flow of invective from the Soviet Union?

There was a time—not many years ago—when modesty was a virtue on both sides of the curtain that now divides the East from the West. Has the proverbial kindness and generosity of the average Russian been lost in exaggerated self-praise of the kind illustrated by the following quotations?

"In opposition to the naive, religious concepts regarding the origin of the world and the idealistic pronouncements of capitalistic science, [our] materialistic science maintains that the universe is infinite in time and in space. . . . It is thus that the minds of the people are being poisoned in the capitalistic countries! Our readers will have a good laugh at these strainings of the foreign devil-worshippers." But "against the background of this impoverishment of science in the capitalistic countries, we in our country create remarkable theories and carry out important observations." A long list of claims follows, some of which are historically incorrect. For example, Ambartsumian did not "discover" the existence of "stellar associations," although he deserves great credit for his remarkably stimulating ideas regarding their na-

ture and origin. Has the memory of Kapteyn been "vaporized" in the Soviet Union and the great Dutch astronomer become an "unperson"? (See Orwell's 1984.)

OTTO STRUVE

Leuschner Observatory  
University of California, Berkeley

### Mercury as a Casting and a Contrast Medium

THE study of the ear is essentially the study of the interior of the temporal bone, since the labyrinth is completely enclosed by the petrous capsule. A technique for preparing metal casts of the petrous bone was described in a previous issue of this journal (1), and this process was later expanded to include the entire temporal bone (2, 3). The need for extending this casting method to embrace the limiting membranes became obvious, and a search was made for lower-fusing metals that would not cook or distort the delicate tissue-membranes of the intact temporal bones of human autopsy specimens or the living ears of experimental animals. The search led to the selection of a metal that needs no heating, but is already molten at normal body temperatures. Thus, mercury was instilled through the round or oval windows, and x-ray studies were made with serial stereoscopic views.<sup>1</sup> This not only reveals the contours and outline of the labyrinth itself, but such associate channels as the endolymphatic and perilymphatic ducts. As a result of these studies it was found that, contrary to the generally accepted opinion, the perilymphatic duct does not communicate with the subarachnoid space of the hindbrain but is limited by a terminal sac, similar to the endolymphatic duct and sac (4).

The channels by which the perilymphatic fluid normally escapes from the confines of the bony labyrinth have long been debated. Prolonged serial x-ray studies of mercury-filled labyrinths in experimental animals show the escape of this fluid through channels that course in the tegmen tympani and traverse the petrotympanic fissure and continue along the Eustachian tube to the lymph nodes of the nasopharynx. The presence of these channels has been confirmed (5) by hard metal casts of the temporal bone and by chemical dye studies (Prussian blue).

When mercury in 2- or 3-ml amounts is injected into the carotid artery of *Macacus rhesus*, the entire carotid system is rendered radiopaque even to the terminal papillary arterioles, but none of the mercury traverses the capillary bed to the venous side, thus giving a true arteriogram. The animals showed no deleterious effects from the mercury instillation during the 3 or 4 hr ensuing before the experiment was finally terminated.

<sup>1</sup> A watertight union may be made with the labyrinth through either of its windows by first inserting a piece of tightly fitting "radio spaghetti" through the window and then forcing the blunted end of the hypodermic needle through the constricted lumen of the spaghetti tube. This may be re-enforced with bone wax, liquid cement, or plaster of Paris, to insure against leakage.

It appears that this cheap and readily available metal offers a superior medium for forming metal casts of various body cavities, as well as a contrast medium for studying fine arterial and lymphatic channels with the aid of x-rays.

M. WHARTON YOUNG

Department of Anatomy, College of Medicine  
Howard University

### References

1. YOUNG, M. W. *Science*, **86**, 619 (1937).
2. ———. *Anat. Record*, **73**, (3), Suppl., 76 (1939).
3. *Ibid.*, **103**, (3), Suppl., 173 (1949).
4. *Ibid.*, **112**, (2), Suppl., 102 (1952).
5. *Ibid.*, **103**, (8), Suppl., 108 (1949).

### Soxhlet Extraction at Reduced Temperature

IN THE course of a study of alkaloids from Tasmanian plants, it was necessary to extract about 1½ kg of material with chloroform, and since the alkaloids extracted were likely to be heat-sensitive, the extraction had to be carried out at as low a temperature as possible. The simple apparatus illustrated in Fig. 1,

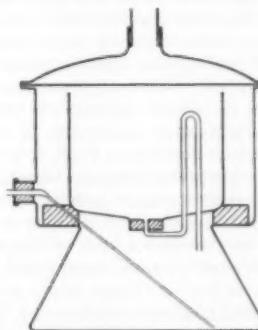


FIG. 1.

which was found to be quite satisfactory for the purpose, consists essentially of three parts. The outer vessel, which contains the boiling chloroform, consists of a large vacuum desiccator, with an opening for evacuation at the side, through which an air or nitrogen leak reaching to the bottom of the vessel can be inserted. The lid of the desiccator is replaced by one from another vacuum desiccator with an opening at the top, on which is mounted an efficient condenser. The two rubber stoppers are protected from the solvent by coating them with a thick paste made from dextrin, maunitol, and glycerol.

The vessel that contains the material to be extracted consists of the upper half of a large bottle with a siphon tube mounted in a cork in the neck. The material is placed in a circular filter paper folded so as to form a large pleated cup fitting inside the extraction vessel.

The apparatus, heated in a water bath, is used under reduced pressure in conjunction with a modified form

of Cartesian diver manostat (1, 2), which maintains the system at any desired constant pressure. The extractor was found to work satisfactorily over extended periods when the pressure was adjusted to give an internal temperature of about 30° C.

I. R. C. BICK  
P. S. CLEZY

Department of Chemistry  
University of Tasmania  
Hobart, Australia

#### References

1. GILMONT, R. *Ind. Eng. Chem., Anal. Ed.*, **18**, 633 (1946).
2. GODWIN, R. D. *J. Chem. Education*, **24**, 511 (1947).

### *Microsporum gypseum* and *Histoplasma capsulatum* Spores in Soil and Water<sup>1</sup>

THE use of a membrane filter for recovery of bacteria from water has been described recently by Clark *et al.* (1). The method entails incubation of an exposed membrane on a sterile absorbent pad saturated with culture medium. We have found that, following exposure to liquids or gases, the membrane may be stained so as to render feasible direct microscopic examination for such relatively large structures as fungus spores and pollen. Such a procedure is, of course, effective only for those organisms producing distinctive and identifiable microscopic structures.

Following filtration of air, water, or other fluids, the membrane is removed to a Petri dish, and an adhesive, such as Haupt's gelatin, is added by dropper to the exposed surface area in order to prevent washing off the spores during the staining process. The membrane is then processed by a modification of the Hotchkiss-McManus (periodic acid-Schiff) technique (2), which stains hyaline fungus spores and mycelium a dark-red against a colorless background. The stained, moist membrane is mounted on a glass slide, under a cover glass, and examined under the microscope.

Application of this technique to aqueous soil extracts has resulted in the finding of numerous tuberculate spores typical of *Histoplasma capsulatum* (Fig. 1, A) in four of four soil samples from Williamson Co., Tenn., an area in which there is an extraordinarily high prevalence of histoplasmin sensitivity among the human population. All the samples tested had previously yielded *H. capsulatum* in culture by means of the mouse-inoculation test (3). That the tuberculate spores occur in soil had been demonstrated earlier by Emmons (4) in Virginia.

Also, by means of the filter method, a tuberculate spore morphologically identical with those obtained from soil and from artificial cultures of *H. capsulatum* has been recovered from a single 1-liter specimen of river water from Williamson Co. This is the first report of the natural occurrence of this organism in water.

<sup>1</sup> Grateful acknowledgment is made to Lawrence B. Hall, of the Communicable Disease Center, for having made available some of the equipment used in this study.

These results suggested the advisability of comparing the membrane filter method with the mouse-inoculation technique for effectiveness in the recovery of *H. capsulatum* from soil. Such a study is now under way.

From one of the above soils there were recovered, in addition, upon the membrane filter, several multi-septate spores typical in all respects of the macro-

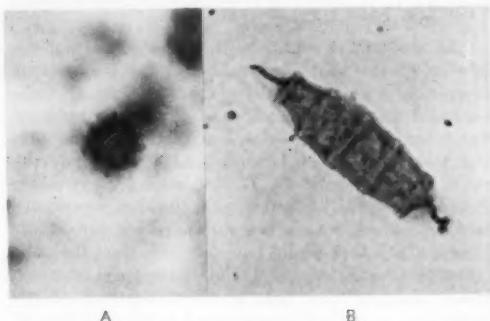


FIG. 1. A, tuberculate spore of *H. capsulatum* recovered from soil; stained on filter membrane.  $\times 760$ . B, macroconidium of *M. gypseum* recovered from water; stained on filter membrane.  $\times 760$ .

conidia of *Microsporum gypseum* (Fig. 1, B). Two strains of *M. gypseum* subsequently were isolated in pure culture from this soil specimen. This dermatophyte had been cultured previously by Mandels *et al.* (5) from wool cloth that had been buried in potted soil in an attempt to isolate keratinophilic fungi from the soil. Whether the isolate of *M. gypseum* had actually originated or was growing in the soil is not certain. According to information received from the laboratories in which the isolation was made,<sup>2</sup> the soil was composed of clay loam, sandy silt, humus, and manure, and had been used in indoor tests for several years. There is no record that the wool had been sterilized prior to burial.

We know of no report prior to the present one of the occurrence of macroconidia of *M. gypseum* in nature. Details of cultural procedures and of the use of filters in spore detection will be reported shortly.

MORRIS A. GORDON  
LIBERO AJELLO  
LUCILLE K. GEORG

Communicable Disease Center

U. S. Public Health Service, Atlanta, Georgia

L. D. ZEIDBERG

Tennessee Department of Public Health  
Nashville

#### References

1. CLARK, H. F., *et al. Public Health Repts.*, **66**, 951 (1951).
2. KLIGMAN, A. M., and MESCON, H. *J. Bact.*, **60**, 415 (1950).
3. AJELLO, L., and ZEIDBERG, L. D. *Science*, **113**, 662 (1951).
4. EMMONS, C. W. *Public Health Repts.*, **64**, 892 (1949).
5. MANDELS, G. R., STAHL, W. M., and LEVINSON, H. S. *Textile Research J.*, **18**, 224 (1948).

<sup>2</sup> Biological Laboratories, U. S. Army Quartermaster Research and Development Laboratories, Philadelphia, Pa.

## Book Reviews

**Principles of Geochemistry.** Brian Mason. New York: Wiley; London: Chapman & Hall, 1952. 276 pp. \$5.00.

Nowadays, one who would write of geochemistry must be prepared to touch upon questions of astrophysics and cosmochemistry, upon what may be termed the protochemistry and the paleochemistry of the developing earth, with its several supposed zones and its aqueous and atmospheric envelopes. In addition, he must treat the chemistry of the mineral constituents of the earth's crust and the physical chemistry of the mineral assemblages, including the changes they suffer under changing environments. This necessarily involves questions of their interaction with each other and with the constituents of the atmosphere and the hydrosphere. In treating these, he cannot neglect certain aspects of biochemistry—for some rocks are the direct result of life processes and others are strongly affected by them. Even though he may nominally confine himself to principles, he must present a far-from-inconsiderable amount of factual data. In short, he sets himself a task of no mean magnitude. Yet in a text of only 254 pages Mason has accomplished this task with astonishing success.

In opening each question he usually offers at least a glimpse of its historical development and proceeds to a statement of the present state of knowledge. When some aspects are in doubt he makes this fact and the basis of doubt clear, as well as indicating the additional data necessary to resolve it. Each chapter ends with a list of references, for each of which a brief résumé of content is given.

The author exhibits almost unnatural restraint. Most authors, including this reviewer, manage to refer to their own writings as often as is reasonably possible, but the name Mason does not appear in the index of the book, although the author has made significant contributions to crystal chemistry and geochemistry.

All in all, it is an excellent book—a model of incisive, authoritative, and lucid scientific writing.

NORMAN L. BOWEN

Geophysical Laboratory  
Carnegie Institution of Washington

**Smithsonian Logarithmic Tables to Base e and Base 10.** Smithsonian Misc. Coll., Vol. 118, Pub. 4054. Compiled by George W. Spenceley, Rheba M. Spenceley, and Eugene R. Epperson. Washington, D. C.: Smithsonian Institution, 1952. 402 pp. \$4.50.

These tables are an adaptation of Hôüel's factorization method of computing logarithms to many places. Tables I and II give the natural and common logarithm to 23 decimal places of XXXX,  $1.0^3$  XXXX, and  $1.0^7$  XXXX, the range of XXXX being from 1 to 10,000.

The natural logarithm of  $N$  is found as follows:  $N$  is expressed in the form  $N = ABCDE$ , where  $A$  con-

sists of the number XXXX formed by the first four digits of  $N$ ;  $B$ ,  $C$ , and  $D$  are numbers of the form  $1.0^3$  YYYY,  $1.0^7$  ZZZZ,  $1.0^{11}$  WWWW, respectively; and  $E$  is the power of 10 necessary to make  $A$  a four-digit number without decimal point. The tables give  $\ln A$ ,  $\ln B$ ,  $\ln C$ ;  $\ln E$  is found by inspection;  $\ln D$ , from the approximate relation  $\ln(1+x) \approx x - (x^2/2)$ ; and  $\ln N = \ln A + \dots + \ln E$ . The error in the 23rd place of  $\ln N$  does not exceed 0.5. Common logarithms are found similarly. Antilogarithms are found readily by the inverse of the process outlined above.

The tables are well bound in a convenient desk size ( $9'' \times 6''$ ) and are easy to read and use. Those who have either occasional or frequent use for logarithms that are accurate to many places will find the tables a welcome addition to the literature—particularly since, for the first time, logarithms are given to 23 places in a concise manner.

The book under review is an extension of certain work done by the senior author in connection with the preparation of the *Smithsonian Elliptic Functions Tables* (1947). All the calculations made to produce the tables were done by hand or on hand desk calculators having 10 columns of 10 keys. This is unusual in these days when large-scale digital engines are commonly used for computing tables. It is indeed an inspiration to know of the painstaking scholarship and the devotion on the part of the authors and their assistants that have gone into the successful preparation of these new tables. Miami University, the Smithsonian Institution, and the Research Corporation of New York are to be commended for their part in helping to make possible the publication of this excellent work.

RICHARD S. BURLINGTON

Bureau of Ordnance, Department of the Navy

**Electrical Measurements.** Forest K. Harris. New York: Wiley; London: Chapman & Hall, 1952. 784 pp. \$8.00.

This book is intended for the student of electrical engineering or of physics, who thus has some acquaintance with the theory of electricity and of electric circuits and a background of mathematics through the calculus. Since the author gives a rather thorough discussion of the topics he covers, he limits the content to direct-current and low-frequency measurements. In particular, the range of topics includes general theory of measurement and electrical units, d-c galvanometers, d-c ammeters and voltmeters, potentiometers, resistance measurements, ballistic galvanometers, magnetic testing, a-c ammeters and voltmeters, power and energy measurements, instrument transformers, waveform and frequency measurements, and a-c bridges.

The author assumes that the student using the book will have a truly professional interest in electricity, that he will not be content to accept without question

the uncorrected indication of any instrument that comes to hand, but that he will want to understand the theory and operation and thus be able to make a critical analysis of the accuracy of any set of measurements. The topics listed above are discussed in a manner consistent with this viewpoint, including a description of each instrument, the history of its development, types of measurements for which it is used, the mathematical theory applicable to its various uses, description of the physical behavior under various operating conditions, definition of constants characterizing the instrument, discussion of sensitivity, stability, and the parameters influencing performance, characteristics of the commonly available commercial forms of the instrument, and factors involved in selecting the best type for a given job. The book is not a laboratory manual, however, and does not contain directions for specific experiments. Nevertheless, the instructor can readily devise his own experiments from the information given about the performance, calibration, and checking of instruments and bridges.

V. A. JOHNSON

*Department of Physics, Purdue University*

*A Colored Atlas of Some Vertebrates from Ceylon: Fishes*, Vol. I. Ceylon National Museums Pub. P. E. P. Deraniyagala. Colombo: Ceylon Govt. Press, 1952. 149 pp. and 34 color plates.

This nicely bound, black-covered volume with gold lettering measures 10½ by 12½ inches. Although it may have been intended for students of general natural history, this atlas has features that make it a work on systematic ichthyology. All the colored illustrations were prepared by the author "from living specimens and a few from freshly killed ones." Some are so intensely colored with brilliant ink that, in many instances, details are lost in the reproduction process, resulting in an unnatural appearance.

The atlas "deals with all the strictly freshwater fishes of the Island and a few marine families, [and] the scientific, local, and popular names of each species are given in the text." Among those illustrated in color, 18 are marine species.

The text consists of keys to families, genera, and species. A page is devoted to the zoogeography of Ceylon, 4 to fossil fishes (mostly teeth), and the remainder to descriptions and observations concerning the 129 species of recent fishes treated. The 60 text figures are more carefully done than the somewhat diagrammatic color plates.

From the point of view of a specialist working in systematic ichthyology, this atlas has some shortcomings. There is evidence that the author has not made extensive comparisons of the fish fauna of Ceylon with that of other related areas and, as a result, has not come to the correct conclusions in regard to certain names used. For example, he refers to *Gymnothorax fimbriatus* as a subspecies of *G. undulatus*, whereas both are distinct species. In his "schematic fish" showing external characters, and how measured, the "stand-

ard length, caudal peduncle, head [length] and origin of first dorsal" are not defined as currently used in ichthyology. There is one new ordinal name—*Mastocembeli*. Two new subspecies were named: *Labeo porcellus lankae* was established loosely as regards present-day standards, since it "differs from the 'forma typica' in its smaller size," whereas *Anabas testudineus kavaiya* "differs from the forma typica in showing some specimens with XV [spines]," yet no statistical tables comparing *Anabas testudineus testudineus* with the new subspecies are given.

The author points out that the fresh-water fish fauna of Ceylon was derived mostly from India, was later isolated, and that some of the species have differentiated into subspecies or full species.

Ceylon is within the tropical Indo-Pacific marine fish faunal area, the world's largest marine fish zone. The "most southerly outpost of India with several thousands of miles of ocean separating it from the nearest land masses to its east, south, and west, it is a way-station past which oceanic species, rare and unknown in Indian waters, travel periodically."

In the references to literature, 41 titles of articles by the author are given. These will be useful to students interested in the zoology of Ceylon, as will the atlas.

LEONARD P. SCHULTZ

*U. S. National Museum, Washington, D. C.*

## Scientific Book Register

*Fouriersynthese von Kristallen und ihre Anwendung in der Chemie*. Werner Nowacki. Basel: Verlag Birkhäuser, 1952. 237 pp. and Tabellen zur Bestimmung der 120 Auslöschungseinheiten. 30.15 Sw. fr.; 34.30 Sw. fr., bound.

*Metallurgy for Engineers: Casting, Welding, and Working*. John Wulf, Howard F. Taylor, and Amos J. Shaler. New York: Wiley; London: Chapman & Hall, 1952. 624 pp. \$6.75.

*Trattato di Malattie Infettive*, Vols. I and II. (In Italian.) E. Carlini and F. Magrassi, Eds. Naples: Edizioni Scientifiche Italiane, 1951. 2446 pp.

*The Scientific Papers of James Clark Maxwell*. Repr. W. D. Niven, Ed. New York: Dover Pub., 1952. 1488 pp. \$10.00.

*The Advance to Social Medicine*. René Sand; R. W. Parnell, Ed.; Eng. trans. by Rita Bradshaw. New York-London: Staples Press, 1952. 655 pp. \$8.50.

*Principles of Chemistry*, 6th ed. Joel H. Hildebrand and Richard E. Powell. New York: Macmillan, 1952. 444 pp. \$4.50. (Bound with 3rd ed. of *Reference Book of Inorganic Chemistry*, \$7.50.)

*Backgrounds of Human Fertility in Puerto Rico: A Sociological Survey*. Paul K. Hatt. Princeton, N. J.: Princeton Univ. Press, 1952. 512 pp. \$5.00.

*Corrosion Testing Procedures*. F. A. Champion. New York: Wiley, 1952. 369 pp. \$6.25.

*The Auricular Arrhythmias*. Myron Prinzmetal et al. Springfield, Ill.: Thomas, 1952. 387 pp. \$16.50.

*The United States Public Health Service 1798-1950*. Ralph Chester Williams. Bethesda, Md.: Commissioned Officers Association of the U. S. Public Health Service, 1951. 890 pp. \$7.50.



Students of Evolution and Genetics  
will find this new book a must for  
graduate work and reference . . .

# EVOLUTION IN THE GENUS DROSOPHILA

by

John Thomas Patterson

•  
Wilson S. Stone

•  
Both of the *University of Texas*

The most extensive treatment of any living genus thus far attempted, this book deals with the evolution of *Drosophila* as demonstrated by living forms, and is mainly concerned with isolating mechanisms, genetic systems shown by hybrids and the cytology of over one third of the known species of the genus.

*Ready in the Fall*

THE MACMILLAN COMPANY  
60 FIFTH AVENUE, NEW YORK 11, NEW YORK

*Why* you can depend on  
proportional  
counters  
by

nuclear  
measurements  
corp.



NMC MODEL PC-3

PRECISION  
IS HIGHER

Total instrumental error is less than 0.5%; the character of the "Candid Decade" scaling circuit guarantees that scaling errors will not participate. No geometry or window error exists. Resolution loss 1% per 100,000 c/m.

YIELD  
IS HIGHER

The yield runs typically 5 to 50 times higher than an end-window GM counter.

BACKGROUND  
IS LOWER

Beta background runs less than 2 c/m<sup>2</sup> per cm<sup>2</sup> of counting area; Alpha background is less than 0.1 c/m.

OPERATION  
MORE RAPID

Built-in automatic features reduce the operating cycle to 4 rapid operations.

DECONTAMINATION  
IS EASIER

Less than 10 minutes is required to decontaminate, clean and reassemble the counting chamber.

VERSATILITY  
EXCEPTIONAL

The instrument counts Alphas, Betas and Gammas. Alphas are counted with complete discrimination from high intensity Beta activity. Betas are counted in the presence of Alpha activity.

DESIGN  
INTEGRATED

Designed specifically for Proportional Counting with the least possible compromise.

You can depend on Instruments by Nuclear Measurements when you need Instruments for

RADIOCHEMISTRY MINERAL ASSAY  
RADIobiology WATER & SEWAGE ASSAY  
RADIOTHERAPY NUCLEAR PHYSICS  
HEALTH PHYSICS MINERAL SEARCH

Contact NMC First  
... For The Finest

**NMC**

nuclear measurements corp.

2450 N. ARLINGTON • CH. 2415 • INDIANAPOLIS, INDIANA

## Publications Received

*Fourteenth-Century Blue-and-White: A Group of Chinese Porcelains in the Topkapı Sarayı Müzesi, Istanbul.* Freer Gallery of Art Occasional Papers, Vol. II, No. 1. John Alexander Pope. Washington, D. C.: Smiths. Inst., 1952. iii + 85 pp. + 44 plates.

*General Education Board Annual Report 1951.* New York: General Education Board, 1952. ix + 83 pp. Illus.

*Handbook of Pharmacology for Nurses.* Robert Shestack. Philadelphia-London: Saunders, 1952. 171 pp. \$3.00.

*A Home Program for Patients Ambulatory with AIDS.* Edward E. Gordon. New York: Natl. Multiple Sclerosis Soc., 1952. 19 pp. Illus.

*Illustrated Key to West North American Gastropod Genera.* A. Myra Keen and John C. Pearson. Stanford, Calif.: Stanford Univ. Press, 1952. 39 pp. Illus. \$1.50.

*Infrared in Relation to Skin and Underlying Tissue.* A bibliography compiled by Ursula Fleck. Washington, D. C.: Tech. Inf. Div., Library of Congress, 1952. 20 pp. 25¢.

*International Sanitary Conditions.* Proc. Special Committee and Fourth World Health Assembly on WHO Regulations No. 2. Geneva: WHO, 1952. 443 pp. \$2.25.

*Laboratory Studies in College Chemistry.* Joseph A. Baber and Alexander Lehrman. New York: Crowell, 1952. 227 pp. \$2.50.

*Man into Wolf.* An anthropological interpretation of sadism, masochism, and lycanthropy. (A lecture delivered at a meeting of the Royal Society of Medicine.) Robert Eisler. New York: Philosophical Library, 1952. 280 pp. \$6.00.

*The Mechanical Properties of Cheese and Butter.* Margaret Baron. London: Dairy Industries, Ltd., 1952. 106 pp. 15s.

*Proceedings of the Conference on Ionospheric Physics (July 1950).* Pt. A, Geophysical Research Papers No. 11. N. C. Gerson and Ralph J. Donaldson, Jr., Eds. 295 pp. Illus. Pt. B, Geophysical Research Papers No. 12. Ludwig Katz and N. C. Gerson, Eds. 115 pp. Illus. Cambridge, Mass.: Geophysics Research Div., Air Force Cambridge Research Center, 1952.

*Proceedings of the First National Conference on Placement of Severely Handicapped.* Washington, D. C.: Am. Federation of the Physically Handicapped, 1952. 74 pp. \$1.50.

*Protective Body Mechanics in Daily Life and in Nursing.* A manual for nurses and their co-workers. Margaret Campbell Winters. Philadelphia-London: Saunders, 1952. 150 pp. Illus. \$3.50.

*Radioactive Atoms and Isotopic Tracers.* Twenty-sixth Annual Priestley Lectures. Joseph W. Kennedy. State College, Pa.: Phi Lambda Upsilon, Dept. Chem., Pennsylvania State Coll., 1952. 89 pp. (Mimeo.) \$2.00.

*Report of the Committee on the Measurement of Geologic Time, 1950-1951.* Pub. 212. Washington, D. C.: National Academy of Sciences-National Research Council, 1952. 140 pp. \$1.00.

*Studies in Brucellosis, III.* A Series of Five Papers. I. Forest Huddleson et al. East Lansing, Mich.: Michigan State Coll. Agr. Expt. Sta., Dept. Bacteriol. Public Health, 1952. 114 pp. Illus.

*World Population Problems and Birth Control.* Ann. N. Y. Acad. Sci., 54, Art. 5. C. G. Hartman et al. New York: N. Y. Acad. Sci., 1952. Pp. 729-868. Illus.

Chi-  
Istan-  
ol. II,  
C.;  
New  
3 pp.  
stack.  
\$3.00.  
Aids.  
Sclero-

tropod  
Stan-  
Illus.

Tissue.  
shing-  
1952.

Com-  
WHO  
\$2.25.  
ph A.  
rowell,

ion of  
re de-  
(medicine.)  
library,

Mar-  
1952.

Physics  
ers No.  
., Eds.  
Papers  
15 pp.  
Div.,

Place-  
D. C.:  
, 1952.

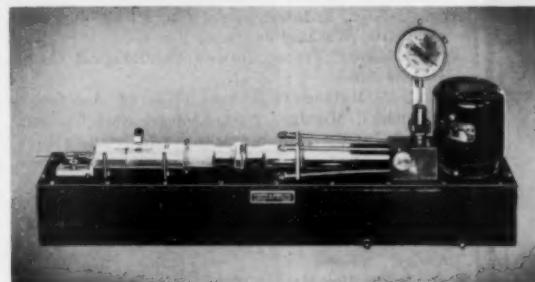
Nursing.  
Margaret  
unders,

ty-sixth  
State  
Penn-  
00.

of Geo-  
D. C.:  
research

Papers.  
Mich.:  
eteriol.

I. Ann.  
et al.  
8. Illus.



BIRD

## Infusion Pump

### A LONG-AWAITED ITEM

THIS new Bird Infusion Pump will meter accurately and continually small quantities of selected liquids, eliminating necessity of constant observation and refilling of syringes.

The close regulation of flow will save you considerable injection fluid, and you will find a smaller number of repeat laboratory experiments required. Operates on 115V, 60 cy.

Cat. No. 71-049

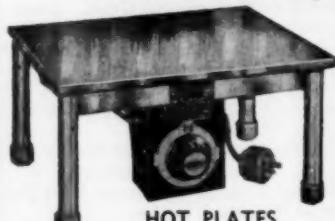
\$500.00

*Phipps & Bird*  
INC.

MANUFACTURERS • DISTRIBUTORS  
RICHMOND, VIRGINIA

## ACCURATE HEAT

*Thermostatically Controlled 100 to 550° F*



HOT PLATES

AE-6541 HEATERS. Electric, Thermostatic Controlled, A.C. Regularly supplied for use on 115 or 230 volts A.C. Please specify which when ordering.

The temperature is accurately controlled by a hydraulic type thermostat with a temperature range of 100 to 550° F. The thermostat has a temperature differential of approximately  $\pm 2\%$  of the temperature setting. The adjustable temperature dial is calibrated in Fahrenheit. The thermostat is supplied with a built-in "off" switch and a neon pilot light.

These hot plates are made of steel with the heating surface highly polished to eliminate stickiness. There is no plating to peel off. The streamlined legs with "ball-type" feet won't scratch.

The long-life strip heaters are firmly clamped to the bottom of the heating plate and are so spaced to assure even heat over the entire plate surface, and are fully enclosed by a metal pan lined with heavy insulation.

Size, inches ..	6 x 6	6 x 12	9 x 12	9 x 15	12 x 18	18 x 24	4 x 24
Max. wattage ..	400	800	1200	1500	2400	4800	1100
EACH ..	\$32.00	\$38.25	\$44.85	\$52.85	\$64.65	\$103.65	\$43.80



STANDARD SCIENTIFIC SUPPLY CORP.  
34 West 4th Street

New York 12, N.Y.



Reg. U. S.

Pat. Off.

## ENZYMES

Acetyl Cholinesterase (20,000 U/vial)  
 Amylopsin 3 U.S.P.  
 Alpha Amylase  
 Beta Amylase  
 Catalase Crystalline  
 Chymotrypsin Crystalline  
 Cocarboxylase  
 Cozymase (coenzyme I) 65% Pure  
 Cozymase (coenzyme I) 90% Pure  
 Cytochrome C (amorphous Powder)  
 Cytochrome C (liquid)  
 Diastase (malt)  
 Desoxyribonuclease 1 x Cryst.  
 Emulsin  
 Erepsein  
 Ficin  
 Glucuronidase  
 Hemicellulase  
 Hyaluronidase  
 Invertase  
 Invertase (Analytical grade with Melibiose)  
 Invertase (Analytical grade without Melibiose)  
 Trypsinogen 1 x Cryst.  
 Urease Powder  
 Uricase Powder  
 Lipase  
 Mycozyme  
 Mylase P  
 Pancreatin  
 Papain Powder  
 Pectinase  
 Penicillinase  
 Pepsin 1 : 10,000  
 Pepsin, 2 x Crystallized  
 Phosphatase  
 Protease  
 Rennet N. F.  
 Ribonuclease, Crystalline  
 Soybean Trypsin Inhibitor, 5 x Crystallized  
 Triphosphopyridine Nucleotide  
 (approx. 65% pure)  
 Triphosphopyridine Nucleotide  
 (approx. 80% pure)  
 Trypsin 1 x Cryst.  
 Trypsin 2 x Cryst.  
 Trypsin 2 x Cryst. (salt free)  
 Trypsin 4 U.S.P.

**A READY REFERENCE**  
 That will Save Time for You

Use this catalog as a "one stop" source of Amino Acids, Vitamins, Carbohydrates, Adenylates, Nucleates, Purines, Pyrimidines, Tetrazolium Salts, Enzymes, Microbiological and Bacteriological Media, Complete Animal Test Diets and Ingredients for investigational use.

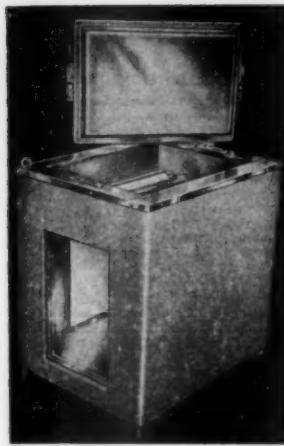
**GENERAL BIOCHEMICALS, INC.**  
 60 LABORATORY PARK • CHAGRIN FALLS, OHIO



WRITE FOR  
 YOUR COPY  
 TODAY

## Meetings & Conferences

- Aug. 31-Sept. 3. International Council of Women Psychologists. Washington, D. C.  
 Aug. 31-Sept. 7. Interamerican Cardiological Congress. Buenos Aires.  
 Sept. 1-2. Mathematical Association of America, Inc. (Summer). Michigan State College, East Lansing.  
 Sept. 1-3. International Spectroscopy Colloquium. London.  
 Sept. 1-6. American Psychological Association. Washington, D. C.  
 Sept. 1-6. International Congress on Astronautics. Stuttgart.  
 Sept. 1-8. World Congress of Anthropology and Ethnology. Vienna.  
 Sept. 1-12. Biological Photographic Association. Hotel New Yorker, New York.  
 Sept. 2-5. American Mathematical Society (Summer). Michigan State College, East Lansing.  
 Sept. 2-5. Conference on Science, Philosophy and Religion. Columbia University, New York.  
 Sept. 2-5. Institute of Mathematical Statistics. Michigan State College, East Lansing.  
 Sept. 2-5. International College of Surgeons, U. S. and Canadian chapters (Annual). Conrad Hilton Hotel, Chicago.  
 Sept. 2-6. Conference on Magnetism. University of Maryland, College Park.  
 Sept. 3-9. International Union for the Protection of Nature. Caracas.  
 Sept. 3-10. British Association for the Advancement of Science (Annual). Belfast.  
 Sept. 4-5. National Conference on Industrial Hydraulics (sponsored by Illinois Institute of Technology). Hotel Sherman, Chicago.  
 Sept. 4-6. American Association of Obstetricians, Gynecologists, and Abdominal Surgeons. The Homestead, Hot Springs, Va.  
 Sept. 4-6. American Physiological Society. New Orleans.  
 Sept. 4-9. International Congress on Analytical Chemistry. Oxford, Eng.  
 Sept. 4-13. International Astronomical Union. Rome.  
 Sept. 4-13. International Society of Photogrammetry. International Congress and Exposition of Photogrammetry. The Shoreham, Washington, D. C.  
 Sept. 5-7. Gerontological Society, Inc. Washington, D. C.  
 Sept. 7-10. American Institute of Biological Sciences. Cornell University, Ithaca, N. Y.  
 Sept. 7-12. International Congress on Medical Records. London.  
 Sept. 7-12. Laurentian Hormone Conference. Mont Tremblant Lodge, Mont Tremblant, Quebec.  
 Sept. 8-10. American Fisheries Society. Baker Hotel, Dallas, Texas.  
 Sept. 8-10. American Society for Pharmacology and Experimental Therapeutics (Fall). University of Wisconsin, Madison.  
 Sept. 8-12. Illuminating Engineering Society, National Technical Conference. Edgewater Beach Hotel, Chicago.  
 Sept. 8-12. Instrument Society of America. Cleveland, Ohio.  
 Sept. 8-12. International Council of Scientific Unions. Columbus, Ohio.  
 Sept. 8-13. International Congress on Neuropathology. Rome.  
 Sept. 8-15. XIXth Geological Congress. Algiers.  
 Sept. 8-15. International Horticultural Congress. London.



Paper Partition  
**CHROMATOGRAPHY**  
Equipment

Cabinets  
Cylinders & Racks  
Miscellaneous  
Accessory Equipment  
Specially  
Designed for  
Paper Partition  
Chromatographic  
Analysis

Write for  
Descriptive  
Brochure

**CHROMATOCAB**

Model B300—Insulated

**BERKELEY CHROMATOGRAPHY DIV.**

University Apparatus Company

Dept. H • 2229 McGee Avenue • Berkeley 3, Calif.

**PHOTOVOLT**  
Line-Operated Electronic  
**MULTIPLIER-PHOTOMETER**  
Mod. 520-M



For the exact measurement  
of extremely low light values  
down to 1/10,000 microlumen.

Write for Bulletin #360 to  
**PHOTOVOLT CORP.**  
95 Madison Ave. New York 16, N. Y.



**KLETT**  
ELECTROPHORESIS

CUSTOM MADE  
TOOL FOR THE ANALYSIS  
OF COMPLEX COLLOID SYSTEMS, AND FOR  
THE CONTROL OF PRODUCTION OF  
PURIFIED PROTEINS, ENZYMES, HORMONES

**KLETT MANUFACTURING CO.**  
179 EAST 87TH STREET  
NEW YORK, N. Y.

# PERSONNEL PLACEMENT

**CLASSIFIED:** 15¢ per word, minimum charge \$3.00. Use of Box Number counts as 10 additional words.

**DISPLAY:** \$17.50 per inch, no charge for Box Number. Correct payment to SCIENCE must accompany all ads. Insertion usually made 2 or 3 weeks after receipt of ad. SCIENCE • 1515 Mass. Ave., N.W., Wash. 5, D.C.

## POSITIONS WANTED

Bacteriologist: age 33, Ph.D. Experienced. Desires research position. Box 275, SCIENCE. X

Biochemist, 35, certified internist. Interests: Hospital chemical laboratory, teaching, parenteral therapy, metabolic disorders, clinical investigation. Box 274 SCIENCE. X

Cytochemist: Ph.D. (Zoology). Research experience in cytology, protozoology, cell physiology. Publications. Teaching experience. Desires research and/or teaching position. Box 270, SCIENCE. 8/22

Microbiologist-Bacteriologist, Ph.D., 35. Thirteen years' responsible teaching and research experience. General microbiology, microbial metabolism. Academic or industrial position desired. Box 263, SCIENCE. 8/22; 9/5

**Positions Wanted:**  
 (a) Internist, Diplomat, teaching fellowship, organic chemistry; three years, instructor (biochemistry, physiology); four years, associate professor of medicine and pharmacology, and director research, medical school. (b) Bacteriologist: M.S.; twelve years, researcher large pharmaceutical company; interested teaching, research, new products developed; able writer. For further information, please write Science Division, Medical Bureau, Burneice Larson, Palmolive Building, Chicago. X

Zoologist-Anatomist—Ph.D. University Professor 14 years experience teaching Biological Sciences desires position with Campus College. Would go anywhere. Rank not important. Box 269, SCIENCE. X

## POSITIONS OPEN

Graduate Assistantships available in bacteriology and botany. Send transcript with application to the Department of Plant Sciences, University of Oklahoma, Norman, Oklahoma. 8/22

Physiologist, Pharmacologist, or Biochemist. Recent Ph.D. with interest in research on endocrine mechanisms. Collaboration in research and light teaching duties in medical pharmacology at leading New England university with half time free for independent investigation. Rank of instructor in pharmacology and salary up to \$5000 for well qualified applicant. Box 273, SCIENCE. X

**Positions Open:**  
 (a) Biochemist preferably physician, Ph.D. eligible, to head division, new general hospital, 600 beds; East. (b) Research Associate, interested biological aspects of endocrinology, biochemical-physiological aspects of radiobiology; well known research organization; South. (c) Parasitologist, medical school; research appointment. (d) Chemist, liberal arts college; rank dependent upon qualifications; Southwest. (e) Bacteriologist; organization conducting research in physical and biological sciences for industry. (f) Organic Chemist qualified pharmaceutical chemistry; key appointment with new products division, one of major chemical companies; Midwest. (g) Physician interested clinical investigation with flair for medical writing; associate directorship, pharmaceutical company. S&E Science Division, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Representatives actively selling educational institutions. Need experienced men to carry our tremendous values in microscopes and all related optics. Straight commission, exclusive territory. Many schools ordering from our national consumer adv. (example: triple-turret 20x-600x achromatic, \$29.95) Phone NOrmandy 3-3754 or wire Mr. Finer, 4400 Sunset Blvd., Los Angeles. X

**SCIENTISTS—salaried positions, \$3,600 to \$25,000.** This confidential service for outstanding men who desire a change of connection, will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. TOMSETT ASSOCIATES • 335 Frick Bldg., Pittsburgh 19, Pa.

# The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

**CLASSIFIED:** 20¢ per word, minimum charge \$5.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

**DISPLAY:** Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

Single insertion	\$17.50 per inch
7 times in 1 year	16.00 per inch
13 times in 1 year	14.00 per inch
26 times in 1 year	12.50 per inch
52 times in 1 year	11.00 per inch

For PROFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

## LANGUAGES

### LINGUAPHONE MAKES LANGUAGES EASY

At home learn to speak Spanish, Portuguese, Italian, French, German, Russian, Japanese, by quick easy LinguaPhone World's Standard Conversational Method. Save time, work, money. Send for FREE book, LINGUAPHONE INSTITUTE, 8408 Radio City, New York 20, N.Y.

## BOOKS

### Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC., Boston 19, Massachusetts

### SCIENTIFIC BOOKS and PERIODICALS WANTED

Complete libraries—Sets and runs—Single titles

Also, please send us your want lists.

STECHERT-HAFNER, INC.  
31 East 10th St., New York 3

### WANTED TO PURCHASE . . .

### SCIENTIFIC PERIODICALS and BOOKS

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N.Y.

### BACK NUMBER PERIODICALS — Bought and Sold

• Tell us what you want!—What have you to offer?

Abrahams Magazine Service ▶ DEPT. P, 56 E. 13th ST.  
Established 1889 ▶ NEW YORK 3, N.Y.

## PROFESSIONAL SERVICES

### LOOKING FOR A PUBLISHER?

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome. VANTAGE PRESS, Inc. • 120 W. 31 St., New York 1. In Calif.: 6356 Hollywood Blvd., Hollywood 28

(THIS IS THE EXACT SIZE RECTANGLE on the Field Finder containing over 20,000 lines and indicia. They form a simple magnifying device so the microscopist is re-located fields of interest in a slide-mounted specimen. Other advantages: Superb precision—with interchangeability; non-destructive; used by substitution.)

WRITE FOR BULLETIN

LOVINS INSTRUMENTS

No. 201-050-150  
Micro-Slide

### FIELD FINDER

LOVINS ENGINEERING COMPANY  
SILVER SPRING, MD.

SINCE 1870



New Food Ingredients • New Drugs

### ANIMAL TESTS

Analyses • Consultation • Research

LaWall & Harrisson

Div. S, 1921 Walnut St., Philadelphia 3, Pa.

# The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT



## PROFESSIONAL SERVICES



### LABORATORY SERVICES

in Biochemistry, Chemistry, Bacteriology  
and Insecticide Testing

Mineral determinations including sodium  
and fluorine

Proximate analyses

Vitamin and amino acid assays

Food biochemistry and microbiology

*Write for price schedule*

**WISCONSIN ALUMNI RESEARCH FOUNDATION**

P. O. BOX 2059 • MADISON 1, WISCONSIN

## SUPPLIES AND EQUIPMENT

### C. P. AMINO ACIDS

and Peptides

for immediate delivery

H. M. CHEMICAL CO., LTD.

1651 - 18th St. Santa Monica, Calif.

### A NEW ANALYTICAL REAGENT

For Derivatives of Polynuclear Hydrocarbons and other Substituted Polynuclear Ring Systems.

#### 2,4,7-TRINITROFLUORENONE

(J. Am. Chem. Soc. 68, 1727, 69, 1225)

Easier and more stable than corresponding picrates.

**DAJAC LABORATORIES** •  
511 Lancaster St., Leominster, Mass.

Continuous Controlled Irradiation  
of Biological Systems

QUANTUM, INC.

Consultation—Equipment—Processing  
Mt. Carmel Station, Hamden, Conn.

*"Your animal is half the experiment"*

### SWISS ALBINO MICE

### ALBINO-W RATS

**albino farms** • P. O. BOX 331  
dept. A RED BANK, N. J.

### ALL AMINO ACIDS

natural, synthetic, unnatural,  
Rare Sugars, Biochemical Products, Reagents, New  
Pharmaceuticals in stock. Write or phone PLaza  
7-8171 for complete price list.

**BIOS LABORATORIES, INC.** 17 West 60th Street,  
New York 23, N. Y.

## PARASITOLOGICAL

### PREPARATIONS

- high quality—low priced. *Write for catalog*

TROPICAL BIOLOGICALS • P.O. Box 2227,  
San Juan, Puerto Rico.

## SUPPLIES AND EQUIPMENT

### TRANSPARENT

PLASTIC BOXES



USEFUL IN ALL LABORATORIES  
FINE FOR HOME WORKSHOPS, ETC.

Five Sizes Now Available

*Write for Leaflet PB-5*

R. P. Cargille 117 Liberty Street  
New York 6, N. Y.

### STAINS

STARKMAN Biological Laboratory

\* RARE

\* COMMON

Price list on Request  
• 461 Bloor St. W.  
Toronto, Canada

### For CONSISTENT Rats . . .

#### • BUDD MT. RODENT FARM

#### • CHESTER, N. J.

*Breeders of a recognized strain of Wistar.*

Wanted: One Wollaston Prism. Will buy outright or rent for approximately 9 months. State terms and dimensions. N. C. State College, Chemistry Department, Withers Hall, Raleigh, N. C. X

### LABORATORY ANIMALS

DOGS BATS RABBITS

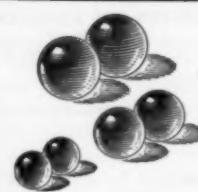
CATS PIGEONS HAMSTERS

MOUSE POULTRY GUINEA PIGS

• Clean healthy well-fed animals  
• Guaranteed suitable for your needs

Reasonably priced—Dependable service

JOHN G. LANDIS • Hazlewood, Md.



### CHEMICAL GLASS BEADS

Made of resistant Bohemian borosilicate glass, especially fire-hardened and alkali-free.

Non-corrosive—non-reactive—can be used in solution with safety and assurance.

Solid—Borosilicate Glass:  $\frac{1}{2}$ , 1,  $1\frac{1}{2}$ , 2,  $2\frac{1}{2}$ , 3,  $3\frac{1}{2}$ , 4, 5 and 6 mm.

Perforated—Crystal Glass: 4, 5 and 6 mm.

Made to  $\pm \frac{1}{4}$  mm. tolerance.

Attractively priced: Send for prices, details and samples.

### PROPPER MANUFACTURING CO., INC.

10-34 44th Drive, Long Island City 1, New York

# GET YOUR ADVANCE COPY

of the General Program-Directory

of the St. Louis Meeting of the AAAS

By first class mail — early in December

The General Program-Directory of the 119th Meeting of the AAAS in St. Louis, December 26-31, 1952, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. This year the General Program will be much simplified in format and the Directory content increased. You will want it for your reference shelf.

#### Program content

1. The General Symposia: "Disaster Recovery" and "The Nation's Nutrition."
2. Programs of the 18 AAAS sections and subsections (symposia and contributed papers).
3. Programs of the more than 30 participating societies.
4. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower II, National Geographic Society, Phi Beta Kappa, RESA, Sigma Xi.
5. Details of the Kiel Auditorium, downtown hotels, Washington University.
6. Titles of the latest scientific films to be shown in the AAAS Science Theatre.
7. Exhibitors in the 1952 Annual Exposition of Science and Industry and descriptions of their exhibits.

#### Directory content

1. AAAS officers and staff for 1952.
2. Complete roll of AAAS presidents and their fields.
3. The 236 affiliated organizations.
4. Historical sketch and organization of the Association.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS.

#### Advance Registration

Advance registration—if you *can* attend the Meeting—has these advantages: 1) You avoid delay at Registration Desks upon arrival; 2) You receive the General Program-Directory in ample time, unhurriedly, to decide among events and sessions you particularly wish to attend; 3) Your name is posted in the Visible Directory as the Meeting opens.

The coupon below may be used both by advance registrants and by those who wish only the advance copy of the General Program-Directory.

#### — THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM-DIRECTORY ——

1a.  Enclosed is \$2.50 for my advance Registration Fee which brings me the Program-Directory, Convention Badge, and all privileges of the Meeting.

1b.  Enclosed is \$1.50 for only the Program-Directory. (If you should attend the Meeting, later, Badge and privileges may be secured for \$1.00 more.)  
(Check one)

2. FULL NAME (Dr., Miss, etc.) .....  
(Please print or typewrite) (Last) (First) (Initial) .....

3. ACADEMIC, PROFESSIONAL, OR  
BUSINESS CONNECTION .....

4. OFFICE OR HOME ADDRESS .....  
(For receipt of Program-Directory)

5. YOUR FIELD OF INTEREST .....

6. CONVENTION ADDRESS .....  
(May be added later, after arrival)

Please mail this Coupon and your check or money order for \$2.50 or \$1.50 to the  
**AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE**  
1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Large stage moves up and down for finer, faster focusing.



The  
*Leitz*

# Panphot Universal Camera Microscope

Only the Leitz PANPHOT enables you to switch from microscopic observation to photo-micrography *without moving from your chair*, for it's the only universal camera microscope

with operating parts for both functions right at hand. Changeover from one to the other is fast, simple, dependable. Now available to industrial and technical laboratories, the PANPHOT is a perfect combination of research microscope and reflex camera.

The PANPHOT permits the use of transmitted light, reflected light, darkfield illumination and polarized light. The permanently aligned light source provides a filament lamp for observation and an arc light for photo-micrography.

Easy observation of the image to be photographed is provided by a large ground glass in the reflex mirror camera. The camera accommodates  $3\frac{1}{4}'' \times 4\frac{1}{4}''$  plates or cut film for black and white or color work.

A full range of accessories is available to equip the PANPHOT for every phase of photo-micrography, photo-macrography and for drawing and projecting micro-images.

Write today for information to Dept. SC

**E. LEITZ, Inc., 304 Hudson Street, New York 13, N. Y.**

LEITZ MICROSCOPES • SCIENTIFIC INSTRUMENTS • LEICA CAMERAS AND ACCESSORIES



## Science Teachers Report

THE  SPENCER  
SCHOLAR'S MICROSCOPE

### HOW THE AO No. 78 SCHOLAR'S MICROSCOPE CUTS TEACHING TIME

1. Easy to learn to use.
2. Single focusing control—fast and precise.
3. Factory-focused built-in light source eliminates time consuming and frequently faulty substage adjustments.
4. Reversed arm position gives clearer view of specimen stage, objectives, and diaphragm openings.

*Since we are currently supplying both military and civilian needs, instrument deliveries cannot always be immediate.*

- The reports keep coming in—yes, the AO Scholar's Microscope *does* save time in teaching students microscopy.

This radically new idea in microscopes has proven a boon to science teachers. The built-in light source assures permanently aligned illumination and consequently better optical performance with much less adjustment. Low overall height increases comfort in operation. Locked-in parts reduce maintenance costs. 'Spring-loaded' focusing mechanism protects slides against damage. See your AO distributor or write Dept. H-4.

American  Optical

INSTRUMENT DIVISION • BUFFALO 19, NEW YORK

